Tuning Pbar Kicker Timing While Stacking

Last Modified: by Brian Drendel
Created: 10-14-05 by Brian Drendel
Send comments and suggestions to the **Pbar Tuning Guide Admins**

Draft Release 0.25

Introduction:

This document is divided into multiple sections. Click on the section title to go directly to the corresponding section.

1. Introduction: The introduction outlines all of the sections contained in this document and provides quick links that allow the reader to go directly to any section.
2. Revision History: The revision history lists the dates and changes made in each major revision of this document.
3. Prerequisites: This is a list of what items need to be tuned before you can complete this procedure.
4. Background: The background section explains why we need to align the kicker timing.
5. Setup: This section outlines what setup is required prior to starting this procedure.
6. Full Length Procedure: This is the full length version of the procedure, complete with screen captures and detailed discussion.
7. Condensed Procedure: This is a condensed version of the procedure without any screen captures, nor discussion.
8. Printable Version: The HTML version of this document is optimized for viewing. Go to the printable version for a PDF file optimized for printing.

Revision History:

Before completing this tuning procedure, make sure that you have already verified that the following tuning has been completed:

1. Draft Release v0.10: 10-14-05 by Brian Drendel. Wrote condensed procedure outline and added first round of screen captures.
2. Draft Release v0.20: 10-20-05 by Brian Drendel. Split up the condensed procedure into ops and experts sections. Added figure tables to screen captures.
3. Draft Release v0.21: 10-24-05 by Brian Drendel. Wrote prerequisites and worked on full length procedure.
4. Draft Release v0.22: 10-26-05 by Brian Drendel. Started to outline information for background section.
5. Draft Release v0.23: 10-27-05 by Brian Drendel. Further developed the background section. Added the scope traces.
6. Draft Release v0.24: 10-28-05 by Brian Drendel. Broke the background section into three sub-sections. Completed background section. Inserted figure numbers and bookmarks to figures. Wrote full length procedure text.
7. Draft Release v0.25: 10-28-05 by Brian Drendel. Entered in Documents Database

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Prerequisites:

Before completing this tuning procedure, make sure that you have already verified that the following tuning has been completed:

1. Before a Debuncher Injection Kicker timing tune-up:
   - Check the Pbar Proton Torpedo from P194 to verify that 81 bunches are detected that are both even in intensity and bunch length. If not, refer to the Main Injector and Booster tune-up procedures.
   - Target Tune
2. Before a Debuncher Extraction and Accumulator Injection Kicker timing tune-up:
   - Contact an Pbar expert as this is an expert-only procedure.

Background:

The purpose of this document is to outline the Pbar kicker alignment procedure. The

background section of this procedure explains why we need to align the kicker timing, and is broken into three sections. Click on a link below to go directly to that section, or scroll down to review the entire document.

Background: Part 1: Bunch Evolution of Protons on Target

A Booster batch consists of 84 bunches of 53MHz beam. The Booster Notcher removes three of those bunches, leaving 81 bunches. The Booster batch is extracted down the MI8 line, where the 8 GeV wall current monitor can detect the individual bunches in the batch. The MI8 proton torpedo (see Figure 1) displays information on the intensity and bunch length of each of the 81 bunches. This display can be used to verify that Booster is sending the correct number of bunches to the Main Injector.

{Insert Picture of 8 GeV Proton Torpedo here}

Figure 1: The MI8 Proton Torpedo. 81 bunches of beam should be extracted in each Booster batch.

Two consecutive 8 GeV 81 bunch Booster batches are injected into the Main Injector and slip-stacked into one 8 GeV 81 bunch batch. The beam is then accelerated to 120GeV in the Main Injector and sent through the P150, P1, P2, and AP1 lines on its way to the Pbar Target. The AP1 wall current monitor can detect the individual bunches in the batch. The Pbar Proton Torpedo (see Figure 2) displays information on the intensity and bunch length of each of the 81 bunches. This display can be used to verify that the Main Injector is sending the correct number of bunches to the AP1 line.

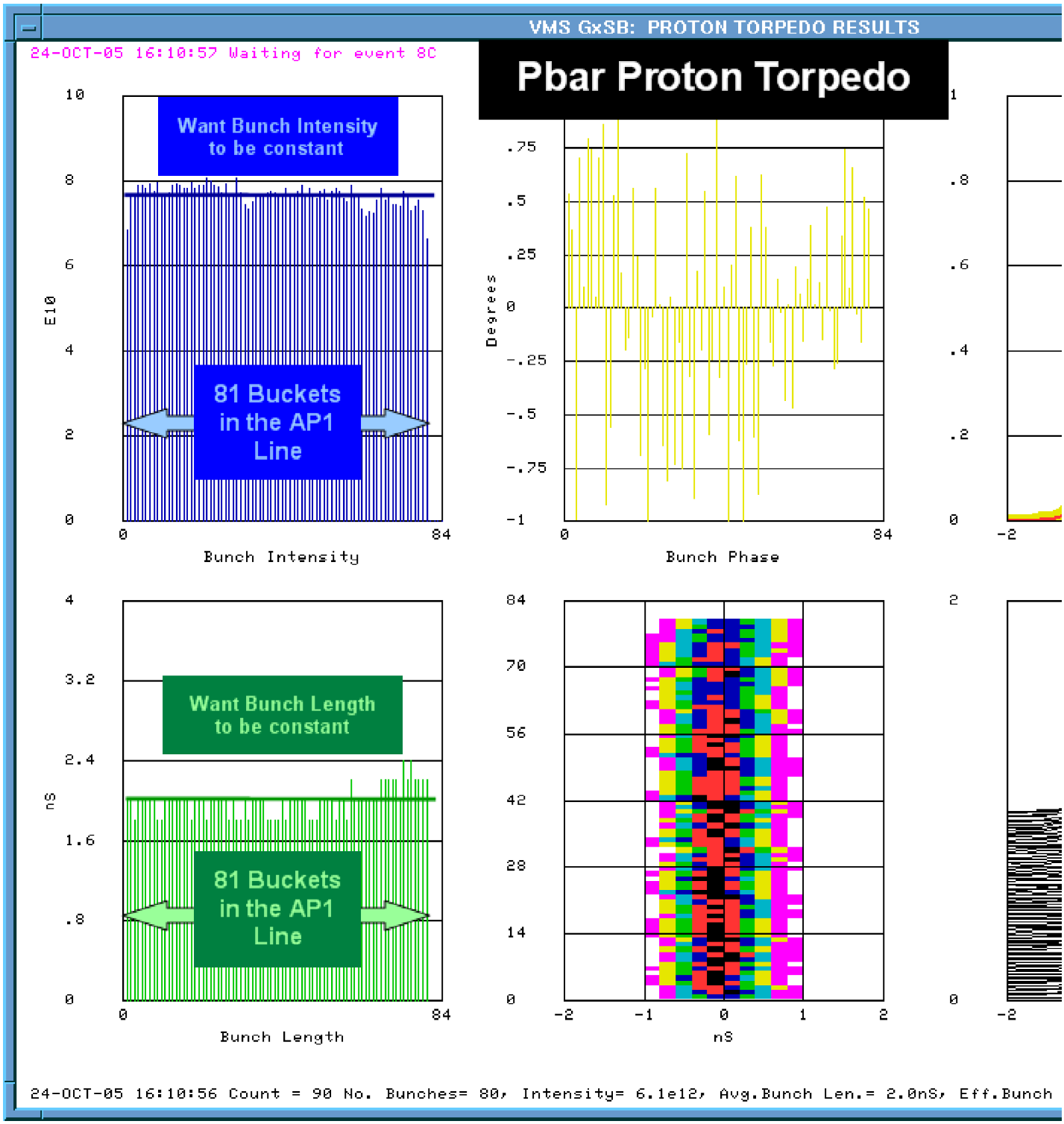

Figure 2: The Pbar Proton Torpedo display uses the wall current monitor in the AP1 line. The display gives us an indication of the structure of the beam on target. We should see 81 bunches that are evenly distributed in intensity and bunch length.

The 120 GeV protons then strike the Pbar target. We collect the negatively charged 8 GeV Pbars plus other particles coming of the target and send them down the AP2 line. The resulting beam has the same bunch structure as the beam on target, so we would expect this beam to contain a string of 81 bunches. We inject the 81 bunches of beam from the AP2 line into the Debuncher using a septum/kicker combination. The septum magnet has two apertures, one for the incoming AP2 beam and one for the circulating Debuncher beam. The septum magnet bends the incoming beam parallel to the circulating Debuncher beam such that the Debuncher injection kicker can kick the incoming beam on the Debuncher closed orbit. Since circulating and incoming beam are in the same aperture at the location of the Debuncher injection kicker, the time that the kickers fire is crucial.

Background: Part 2: Debuncher Injection Kicker Timing

Debuncher Injection Kicker, shown in Figure 3, is single-turn transmission line pulsed magnet consisting of three meter long modules. Each module has its own trigger circuitry that tells the kicker when to fire, and its own pulsed forming network that determines the shape and duration of the kicker pulse.

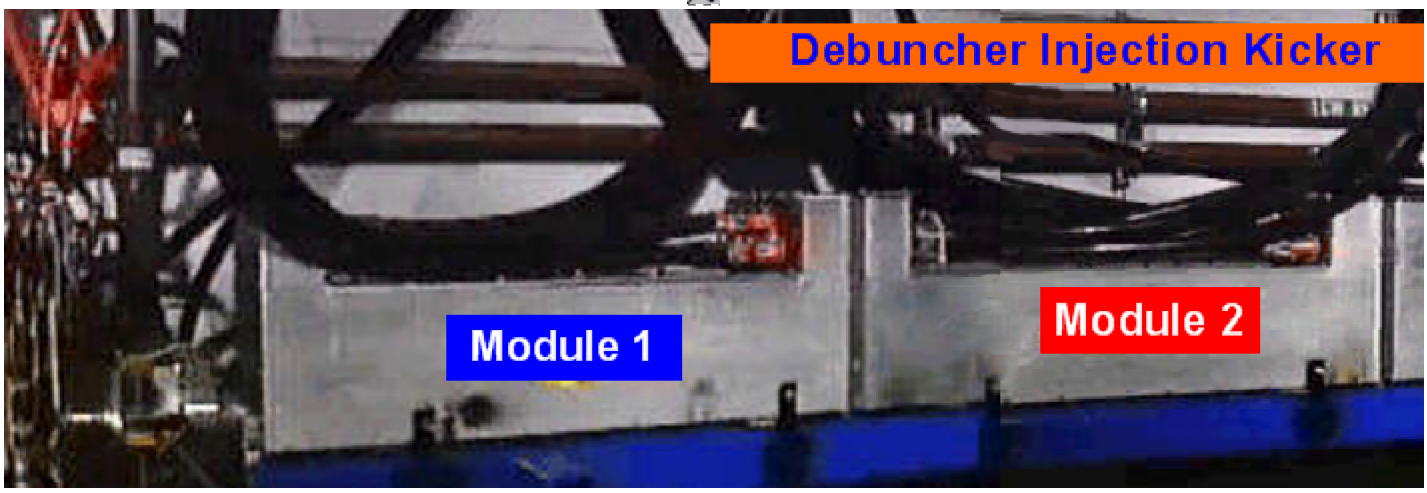

Figure 3: The Debuncher Injection Kicker.

There is an oscilloscope setup that watches the relative timing between the three kicker modules. This scope can be viewed via a web browser at the address http://deb-ikik-scope.fnal.gov/. If the kicker modules are timed relative to each other, then the peaks of the traces will line up as shown in Figure 4.

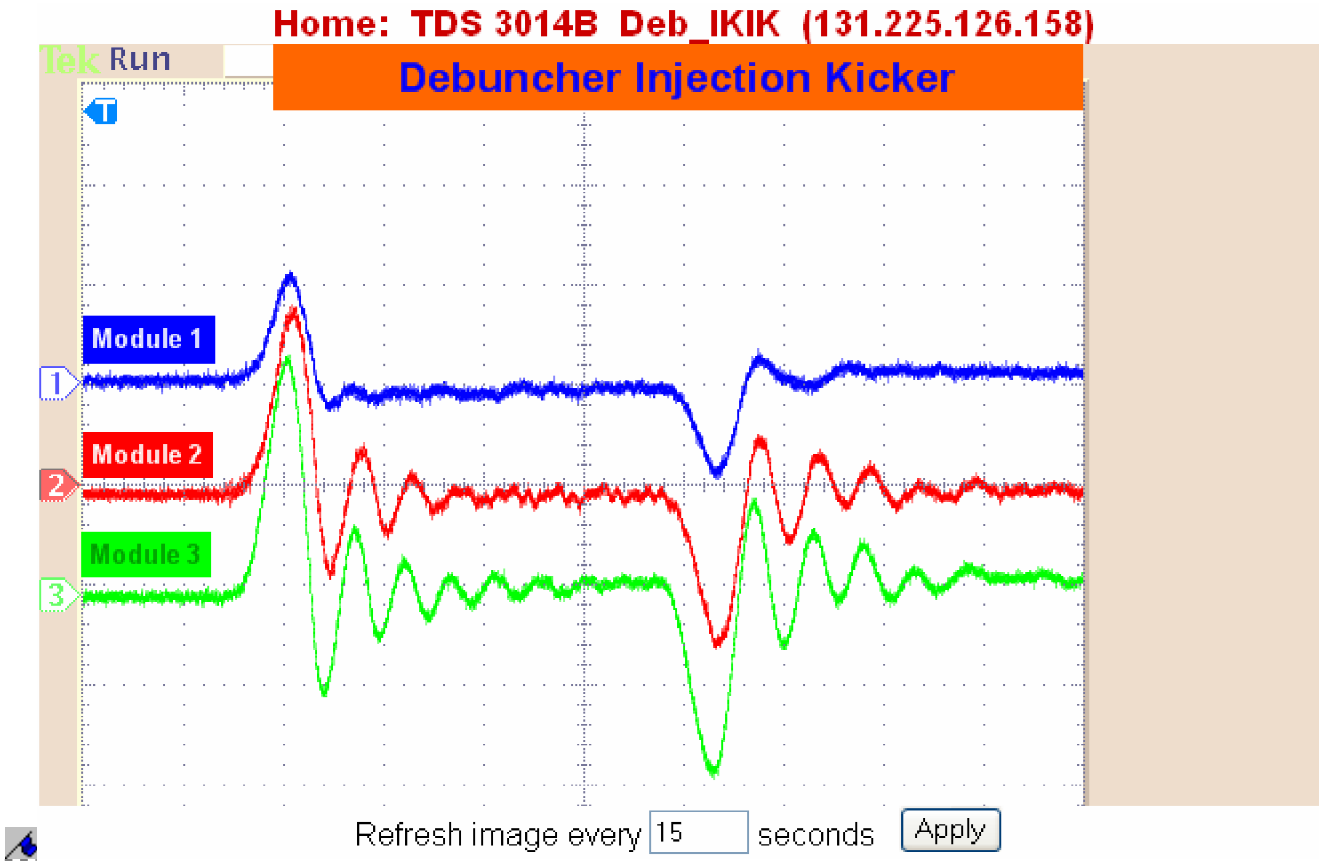

Figure 4: The Debuncher Injection kicker scope. If the kicker modules are timed correctly with respect to each other, the peaks on the left portion of the trace will be aligned. We can see in this screen capture a slight misalignment of module 2.

It is very important that the timing of these modules is set precisely. Each kicker module must be at full current when the beam from AP2 arrives so that the magnetic field from the kicker can put the injected beam on the Debuncher closed orbit. Likewise, once the injected beam has circulated around the Debuncher and is again at the kicker location, each kicker module must be at zero current so that the kicker does not disturb the circulating Debuncher beam. If the kickers are ramping up or down while beam is going by, that beam will be lost. To make a hole for the kickers to fire, DRF2 maintains a 200nsec gap in the Debuncher beam. When timed properly, the barrier bucket gap passes over the Debuncher injection kickers during the time that the kickers fire, minimizing beam loss due to the firing of the kicker.

How can we tell if our kickers are firing at the correct time in relation to our gap? The Flux Capacitor Scope connects to Debuncher gap monitor to collect information about the beam injected into the Debuncher. This scope can be viewed either from CATV Pbar #18 or online at http://ap10-flux-scope.fnal.gov/ as shown in Figure 5. The scope shows the DRF2 waveform and the 81 buckets after they have been injected into the

Debuncher. The display of 81 buckets should have the same structure as the 81 buckets viewed with the Proton Torpedo displays (see Figure 1 and Figure 2). If the Proton Torpedo shows that there are 81 buckets on target, but the Flux Capacitor shows reduced intensity or missing bunches on either the front or back end of the beam distribution, then we may suspect a kicker timing issue. Sometimes this is hard to see by eye, so tools have been developed to quantify this information.

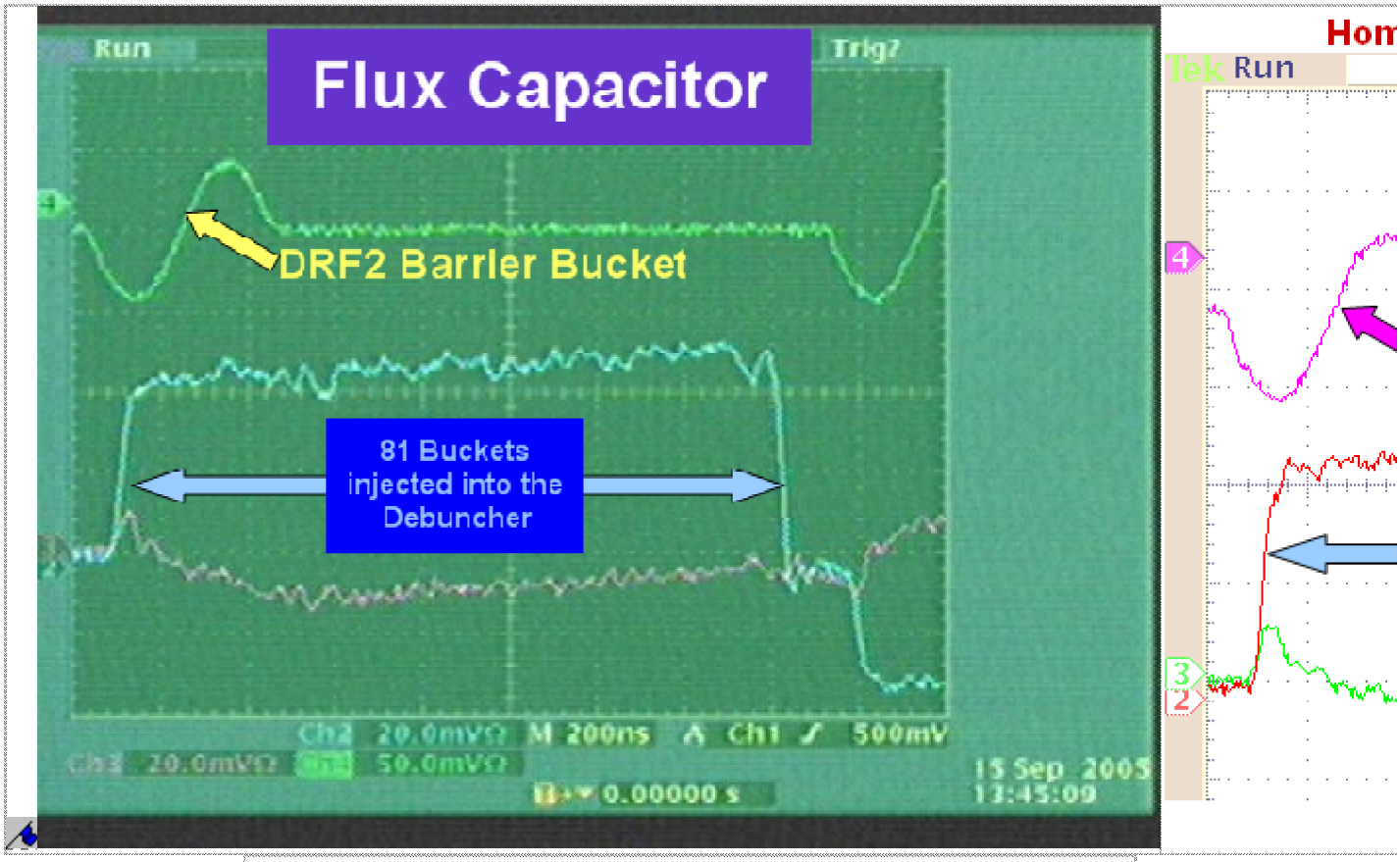

Figure 5: The flux capacitor scope is used to indication how much beam is being injected into the Debuncher. The scope can be displayed either from CATV Pbar #18 (plot on the left) or online at http://ap10-flux-scope.fnal.gov/ (plot on the right). The Cyan trace shows the bunches injected first turn in the Debuncher. The height of the trace is an indication of intensity and the width of the trace is an indication of how many consecutive bunches are injected. Ideally, we would like to see a square wave of 81 consecutive bunches.

Paul Derwent constructed an OAC that examines the Flux capacitor display (Figure 5) and outputs ACNET parameters. D:FLXBTL is the length in μsec of the injected beam, D:FLXBBK is the equivalent number of buckets in that injected beam, and D:FLXGBK is the number of buckets in the gap. A couple of simple calculations can show us the ideal values for the above parameters. The Debuncher has a 53MHz harmonic number

of 90 buckets. It takes beam 1.695 µsec to complete one revolution, so the transit time per bucket is about 0.019 µsec. We know that the incoming 53MHz structured beam from AP2 should be 81 bunches long. That means that we will be filling 81 of the available 90 buckets in the Debuncher, and those 81 buckets would have a transit time of 1.5255µsec. That leaves a 9 bucket gap in the beam, whose transit time would be 0.1695 µsec. If our kicker timing is optimized we should see 81 buckets in the beam train and a gap of 9 buckets. So the ideal values for the OAC generated parameters are D:FLXBTL = 1.5255 µsec (smaller is worse), D:FLXBBK = 81 buckets (smaller is worse), and D:FLXGBK = 9 buckets (larger is worse). We can examine the above parameters to determine if the kicker timing is optimized. If not there are ACNET parameters that allow us to adjust the firing times of each kicker module (D:IKIKM1, D:IKIKM2, D:IKIKM3).

We now have all of the information needed to understand what we need to tune. Our goal in tuning the Debuncher Injection kicker timing is two-fold :

1. Align the three kicker modules to fire synchronously by lining up the three traces from the kicker scope (Figure 4)
2. Have the kicker firing time centered on the DRF2 gap by maximizing D:FLXBTL or D:FLXBBBK from the Flux Capacitor (Figure 5).

A Java application has been developed to do all of this work for us. The use of this application is the topic of the written procedure below.

Background: Part 3: Debuncher Extraction and Accumulator Injection Kicker Timing

Beam only stays in the Debuncher until shortly before the next stacking cycle. Afterwards, beam is extracted to the D/A line and then injected into the Accumulator. Both transfers involve kickers, whose timing modules we can tune. The timing of the modules in each of the kickers as well as the relative timing of the two kickers is important to optimize the transfer of the Debuncher beam to the Accumulator.

The beam is Debunched in the Debuncher, so we have lost our 81 bucket structure; however, we still have the 200nsec gap in the beam preserved by DRF2. The beam is cooled and circulates on the order of a few seconds before it is kicked off of the closed Debuncher orbit with the Debuncher extraction kicker. The kicked beam goes through the field aperture of the Debuncher Extraction septum and on to the D/A line. This Debuncher extraction kicker must have it's rise time inside of the DRF2 gap in order to most effectively extract the beam. Like the Debuncher Injection Kicker, the Debuncher Extraction Kicker (see Figure 6) consists of three separate modules. Each module has

its own trigger circuitry that tells the kicker when to fire, and its own pulsed forming network that determines the shape and duration of the kicker pulse.

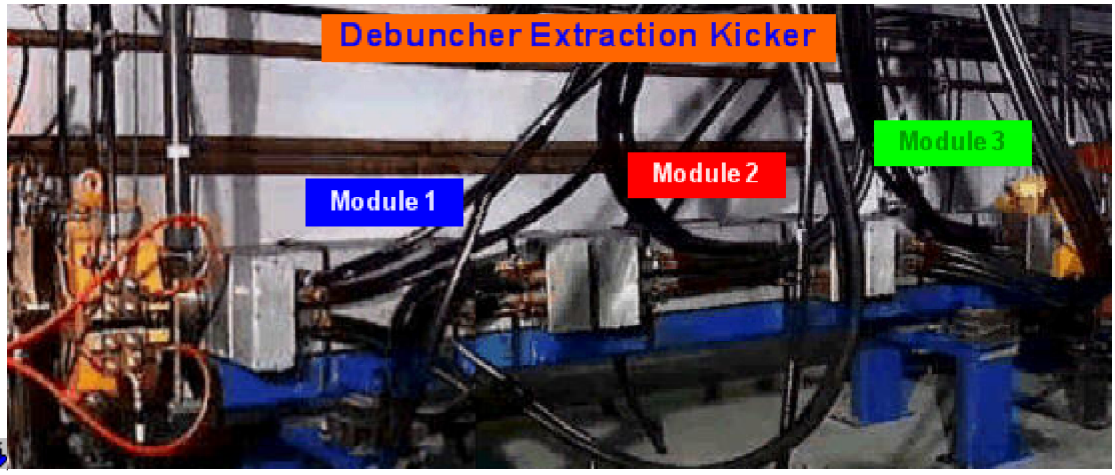

Figure 6: Debuncher Extraction Kicker

There is an oscilloscope setup that watches the relative timing between the three kicker modules. This scope can be viewed via a web browser at the address http://deb-ekik-scope.fnal.gov/. If the kicker modules are timed relative to each other, then the peaks of the traces will line up as shown in Figure 7.

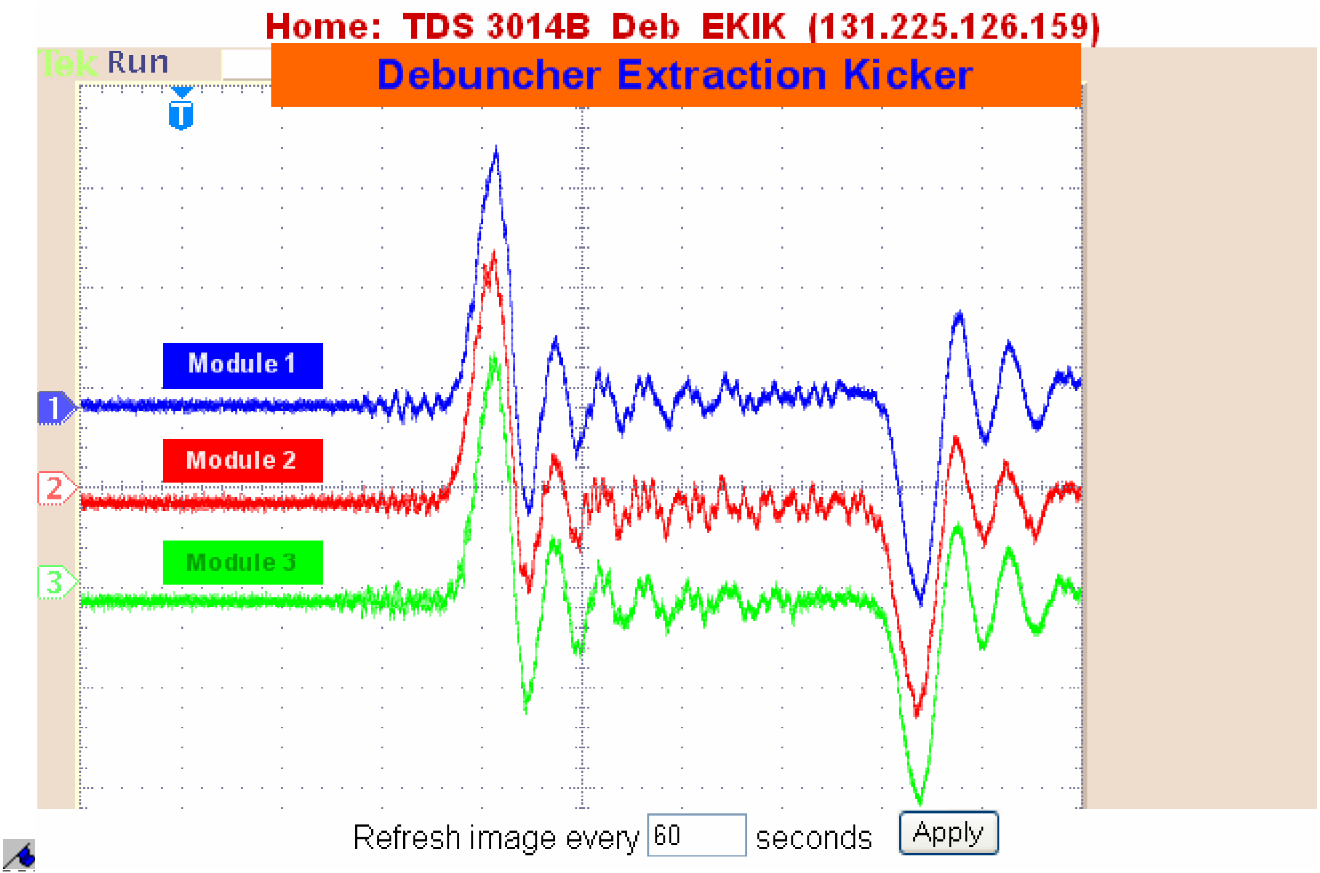

Figure 7: Debuncher Extraction Kicker Scope traces.

Unlike the Debuncher Injection Kicker, we do not have good diagnostics to show us where the kickers fire in relation to the DRF2 gap in the beam. The java application covered in this procedure can be used line up the individual modules with respect to each other, but has no way to align them with the gap. The best way we have to align this kicker with the gap is to carefully change a MULT:3 of D:EKIKM1, D:EKIKM2, and D:EKIKM3 while watching beam in the Accumulator. This type of tuning is usually left for Pbar experts only.

Beam from the D/A line passes through two Accumulator Injection Septum magnets that put in the incoming D/A beam parallel to the circulating Accumulator beam. The injected beam is kicked onto the Accumulator injection orbit using the Accumulator Injection Kicker (see Figure 8). The injection orbit is physically separate from the circulating core, and there is also no gap in the circulating core beam. As a result, the Accumulator Injection Kickers have an Aluminum plate, called the shutter, that drops between the injection orbit and core beam when the kickers fire. This shields the circulating core beam from the kicker pulse. As a result of having to engineer a shutter into the kicker design, the three kicker modules and shutter are all enclosed in one large tank.

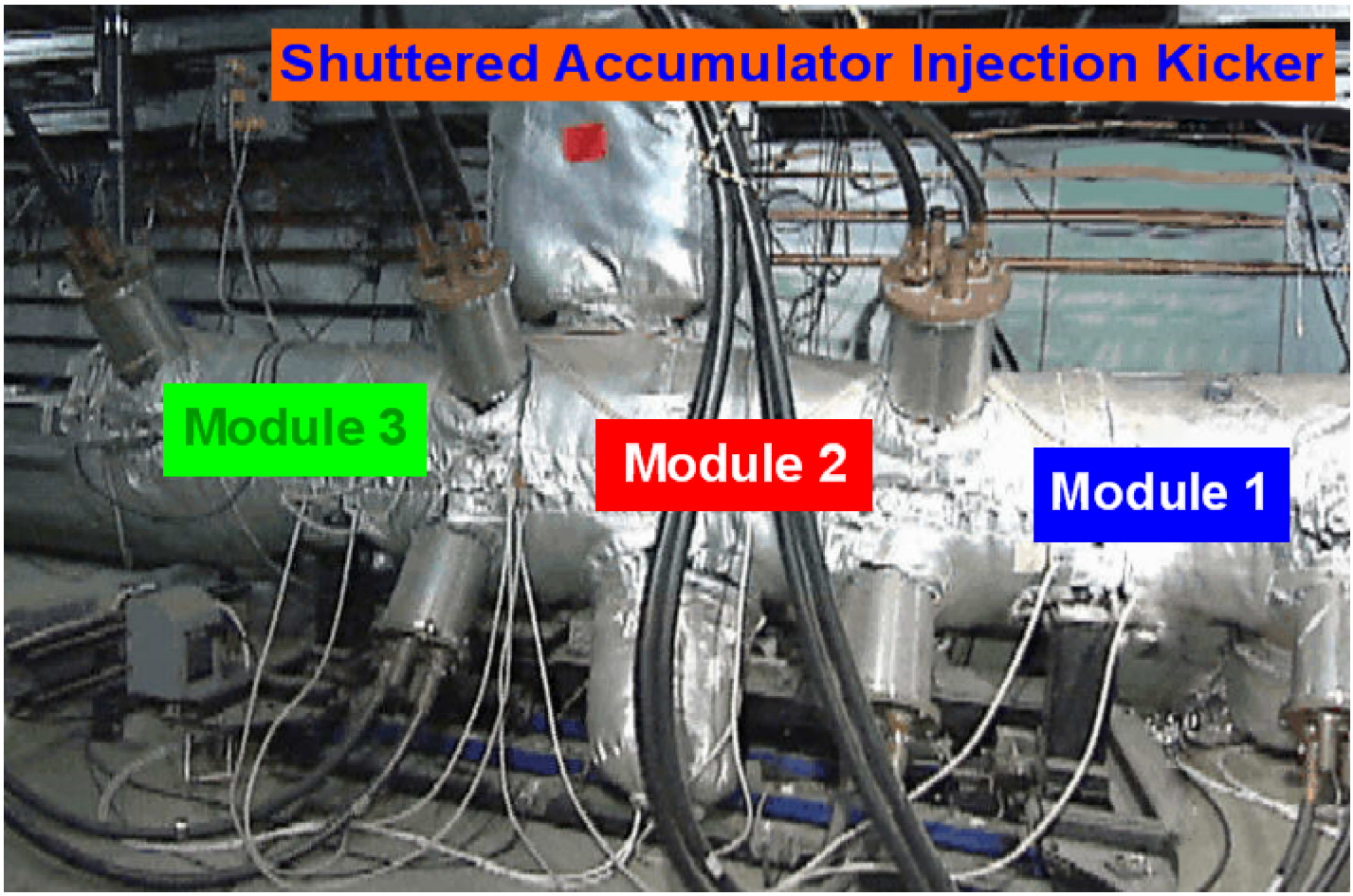

Figure 8: Accumulator Injection Kicker

There is an oscilloscope setup that watches the relative timing between the three kicker modules. This scope can be viewed via a web browser at the address http://acc-ikik-scope.fnal.gov/. If the kicker modules are timed relative to each other, then the waveforms will line up as shown in Figure 9.

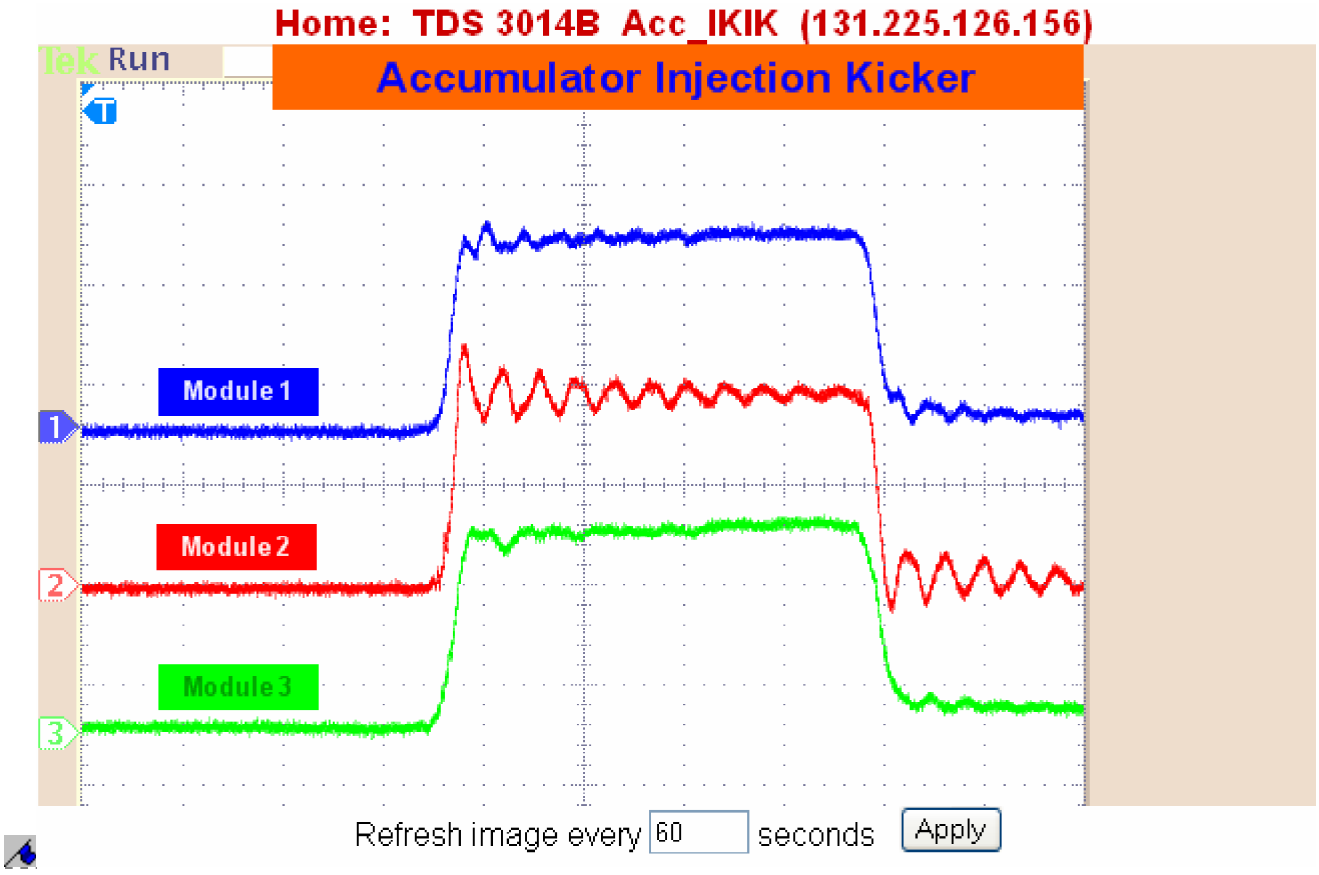

Figure 9: Accumulator Injection kicker scope.

We do not have good diagnostics to show that the Accumulator Injection Kicker timing is aligned with the incoming D/A line beam. The java application covered in this procedure can be used line up the individual modules with respect to each other, but has no way to align them with the beam. The best way we have to align the Debuncher Extraction kicker to the Accumulator Injection kicker is to carefully change a MULT of A:IKIKM1, A:IKIKM2, and A:IKIKM3 and watch beam in the Accumulator. We also can carefully change a MULT of A:IKIKM1, A:IKIKM2, A:IKIKM3, D:EKIKM1, D:EKIKM2, and D:EKIKM3 and watch beam in the Accumulator to align the Debuncher Extraction Kicker and Accumulator Injection Kicker times with the DRF2 gap. This type of tuning is usually left for Pbar experts only.

Setup

You will need to start the Java Kicker Timing Application. Details are given in the full length procedure below.

Full Length Procedure - Introduction

The following steps should be completed to align the Pbar kicker timing while stacking. This section contains screen captures and detailed discussion. If you are already familiar with this procedure and would prefer to review a condensed version of this procedure, then click here. The procedure is broken into the following parts. Click on the link to go directly to that part of the procedure, or scroll down to view the entire procedure.

a. **Part 1: Start the Java Kicker Timing Application (Ops or Pbar Experts)**
b. **Part 2: D:IKIK timer tuning (Ops or Pbar Experts)**
c. **Part 3: D:EKIK & A:IKIK timer tuning (Pbar Experts only)**

This document is under construction...only the condensed version of this procedure is currently available.

Full Length Procedure - Part 1: Starting the Java Kicker Timing Application

1. The Pbar Kicker Timing Java application (See Figure 10) can be started by clicking on the following link: http://www-bd.fnal.gov/appix/start?p=40000142&n=35000508. The application can also be started from the Java Index. Click on "Launch in Application Browser." The Application Index window appears. Open the P * Pbar folder and double click on "Pbar Kicker Timing."

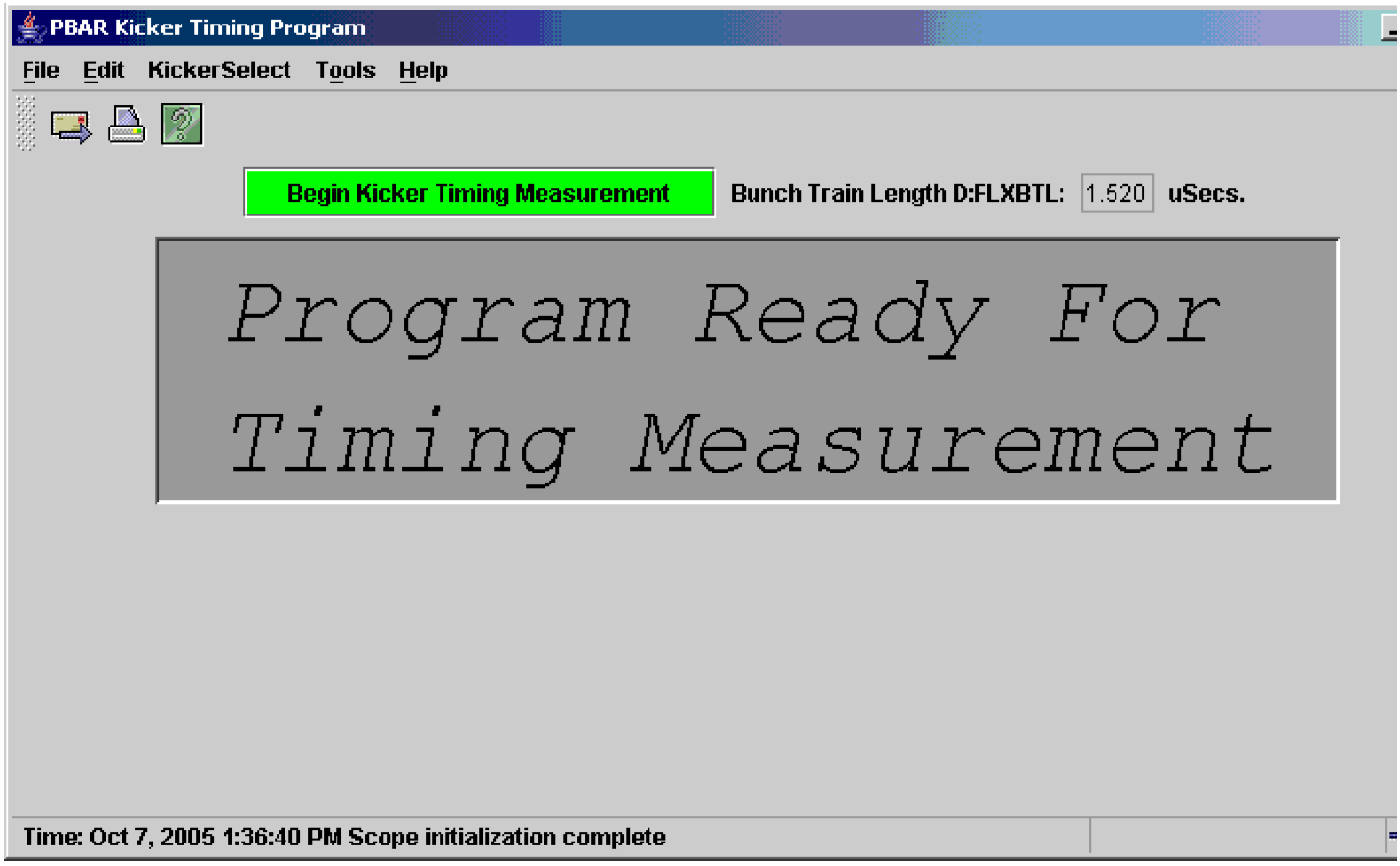

Figure 10: Java kicker scope trace

Full Length Procedure - Part 2: Debuncher Injection Kicker Tuning (Ops or Pbar Experts).

This portion of the procedure will cover tuning the Debuncher Injection Kicker timing. We assume that the Java Kicker Timing application has been started as shown in Part 1 of this procedure.

1. As shown in Figure 11, start a FTP from Utility Window FTP Pbar File 87.

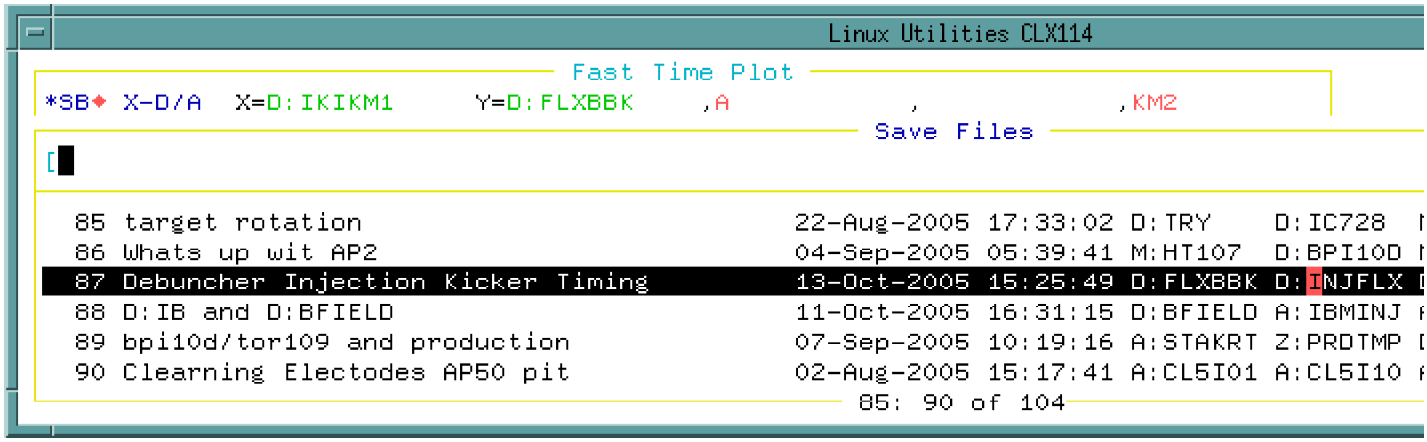

Figure 11 From the Utilities Window, click on FTP, then click on Restore, and then select P-bar. Select file 87 and start the FTP.

2. Pbar FTP #87 (shown in Figure 12) will show how our tuning efforts impact the number of bunches injected into the Debuncher (D:FLXBBK), the calculated Debuncher injection flux (D:INJFLX), the circulating Debuncher beam normalized to beam on target (D:BPI10D/M:TOR109). Larger numbers are better for all three traces.

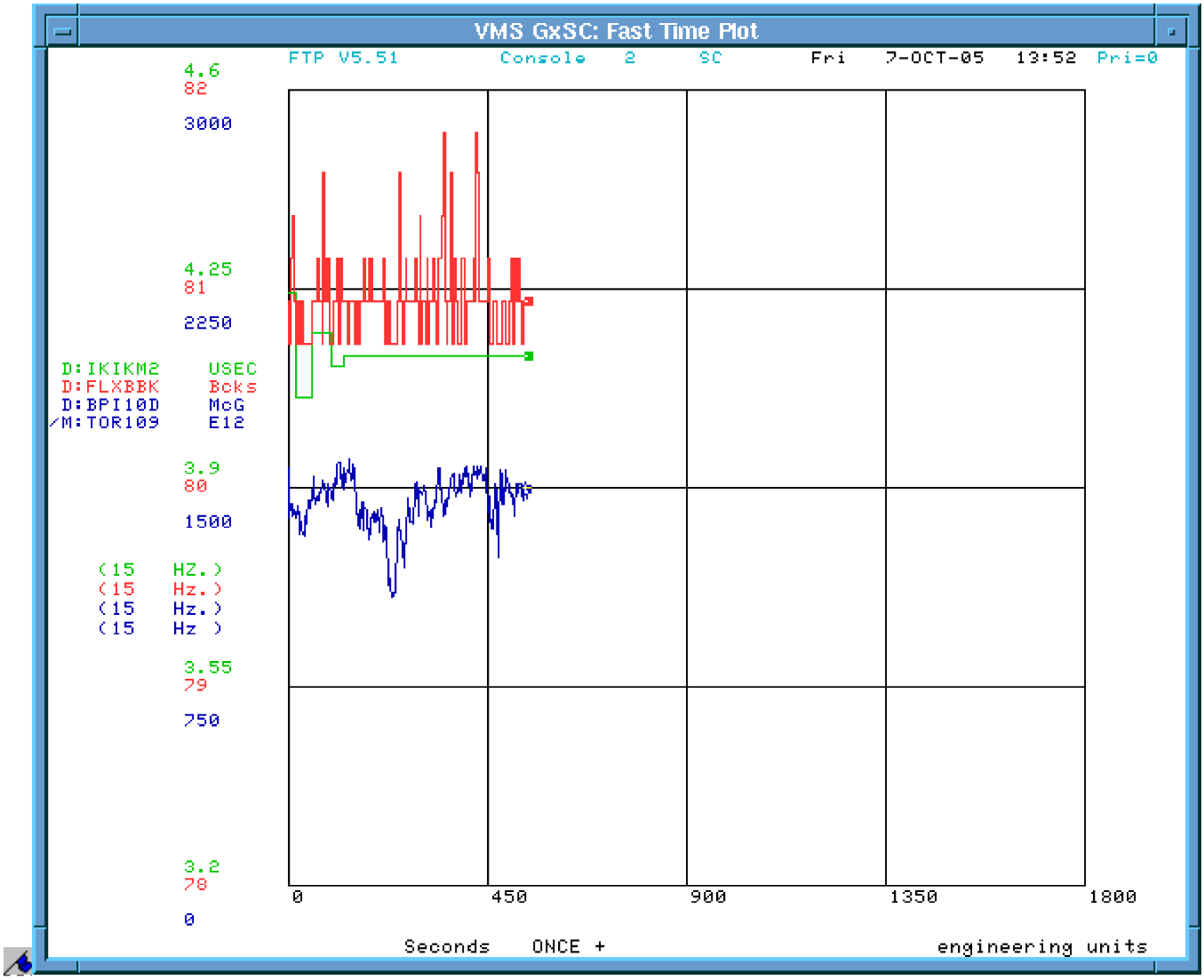

Figure 12: Pbar FTP #87 shows how our tuning efforts impact the number of bunches injected into the Debuncher (D:FLXBBK), the calculated Debuncher injection flux (D:INJFLX), the circulating Debuncher beam normalized to beam on target (D:BPI10D/M:TOR109).

3. Also pay attention to the Flux Capacitor scope. This scope can be viewed from CATV Pbar #18 as shown in Figure 13, or online at http://ap10-flux-scope.fnal.gov/ as shown in Figure 5.

Figure 13: Flux Capacitor Scope:

4. All of the OAC generated Acnet Parameters and the Debuncher Injection kicker timing parameters are located on P60 BOSTR <36>, as shown in Figure 14. The Java Application has a restore kicker timing feature; however, it is still recommended to have this page open.

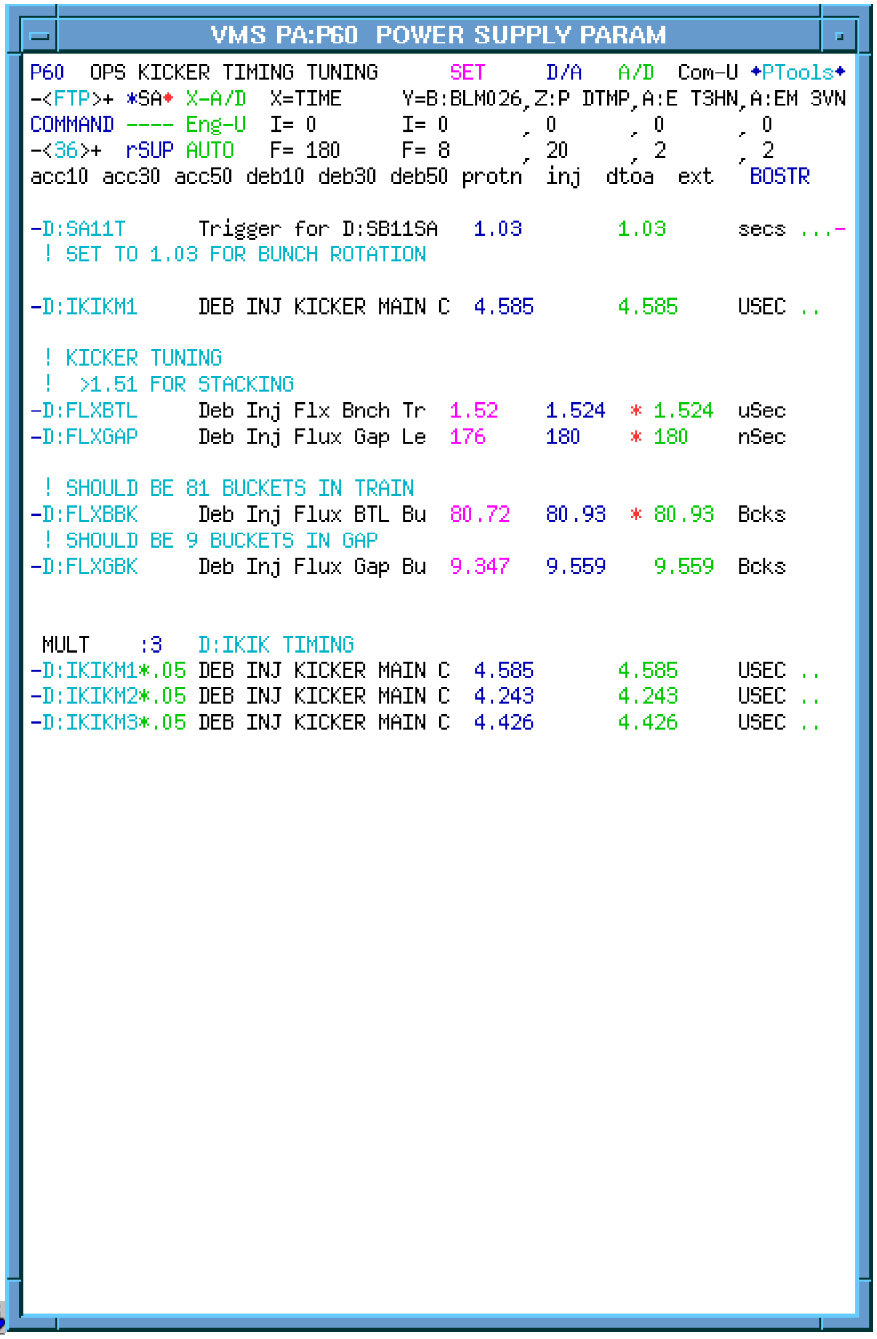

Figure 14: P60 BOSTR <36> has all of the parameters that we need to complete the Debuncher Injection Kicker timer tune-up.

5. From the Java Kicker Timer Program application, go to "KickerSelect" -> "DebuncherInjection" as shown in Figure 15.

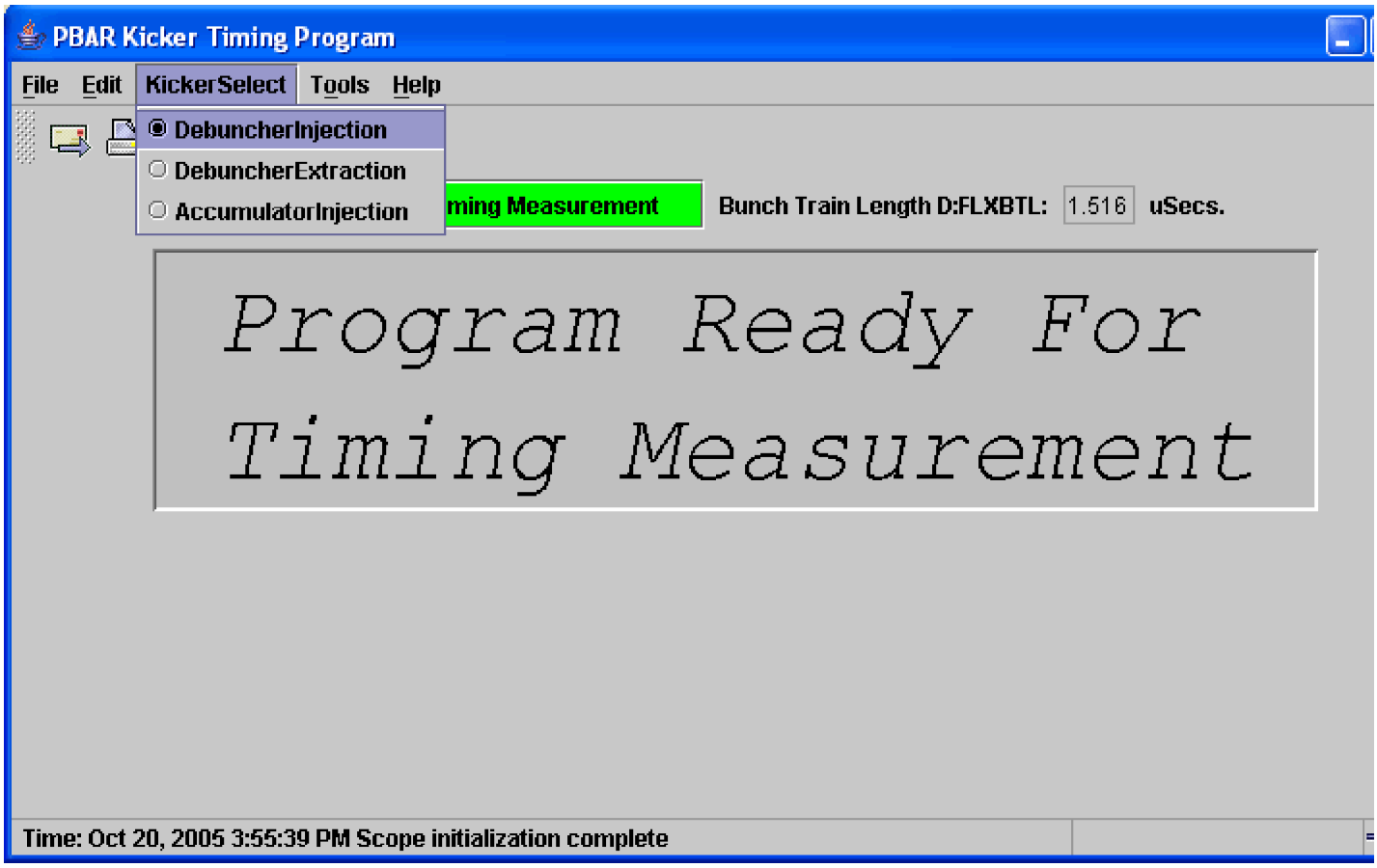

Figure 15: The Java Pbar Kicker Timing Program. Click on "KickerSelect" and then select "DebuncherInjection"

6. Click on the green box that is labeled "Begin Kicker Timing Measurement" as shown in Figure 16. Note the value of D:FLXBTL.

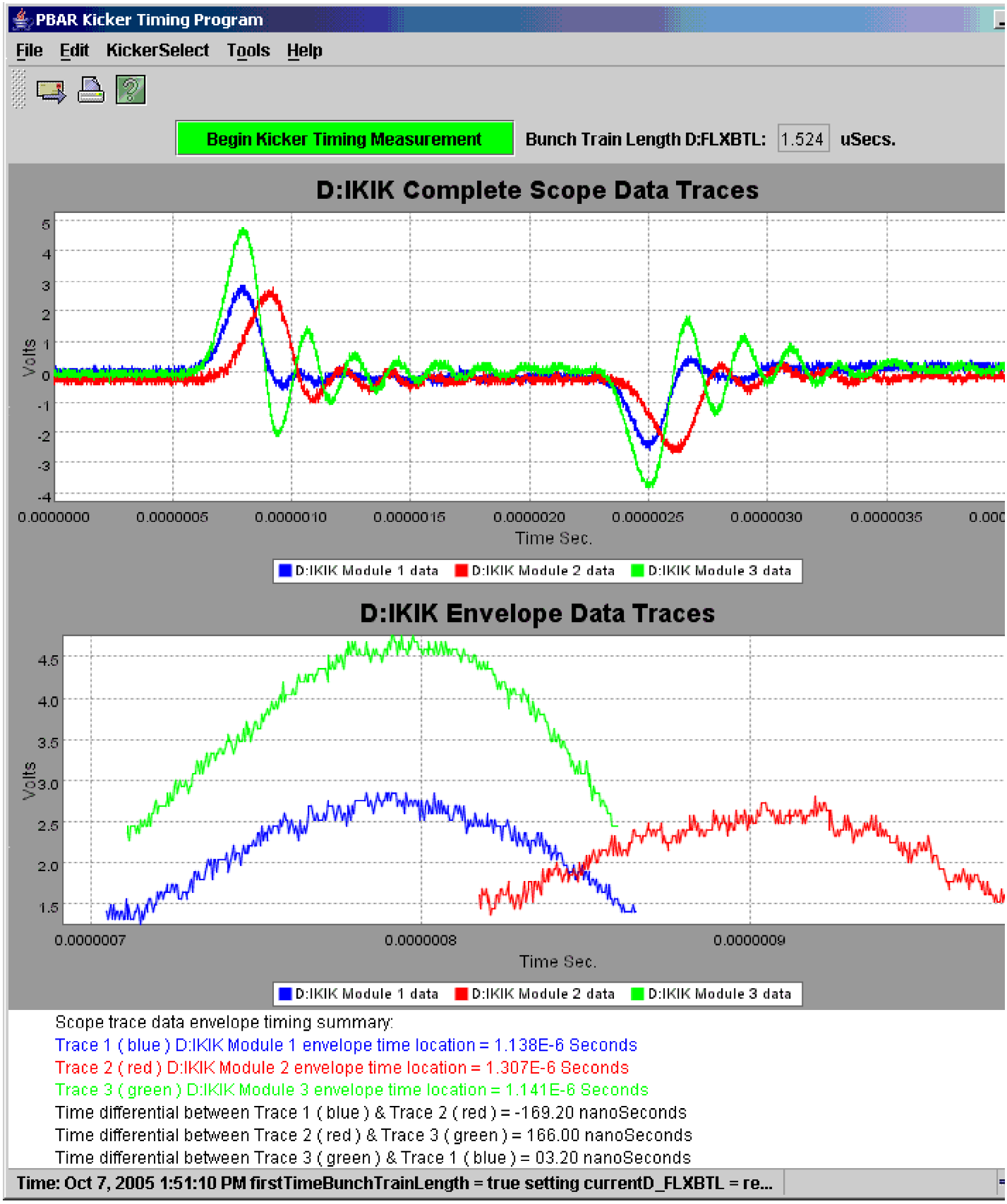
PBAR Kicker Timing Program
File Edit KickerSelect Tools Help
Begin Kicker Timing Measurement
Bunch Train Length D:FLXBTL: 1.524 uSecs.
D:IKIK Complete Scope Data Traces
Volts
Time Sec.
D:IKIK Module 1 data
D:IKIK Module 2 data
D:IKIK Module 3 data
D:IKIK Envelope Data Traces
Volts
Time Sec.
D:IKIK Module 1 data
D:IKIK Module 2 data
D:IKIK Module 3 data
Scope trace data envelope timing summary:
Trace 1 (blue) D:IKIK Module 1 envelope time location = 1.138E-6 Seconds
Trace 2 (red) D:IKIK Module 2 envelope time location = 1.307E-6 Seconds
Trace 3 (green) D:IKIK Module 3 envelope time location = 1.141E-6 Seconds
Time differential between Trace 1 (blue) & Trace 2 (red) = -169.20 nanoSeconds
Time differential between Trace 2 (red) & Trace 3 (green) = 166.00 nanoSeconds
Time differential between Trace 3 (green) & Trace 1 (blue) = 03.20 nanoSeconds
Time: Oct 7, 2005 1:51:10 PM firstTimeBunchTrainLength = true setting currentD_FLXBTL = re...

Figure 16:

7. If any tuning changes are required, you will get a popup window, as shown in Figure 17, that states that D:IKIK has timing module differences that exceed 20 nanoseconds. If all of the kicker times are within 20 nanoseconds, you will get a popup window like that shown in Figure 20, and can then skip ahead to Step 11 of this procedure.

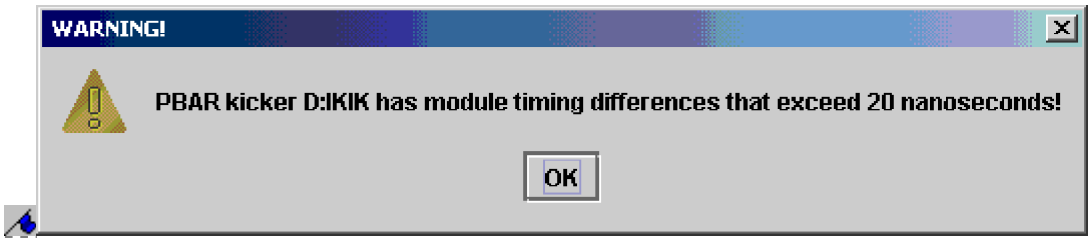

Figure 17: Click OK to continue with the tuning changes.

8. The Timing Results window (see Figure 18) presents the results and suggested tuning options. If the changes look reasonable, then make the suggested changes. It is normal to make ~200nsec changes.

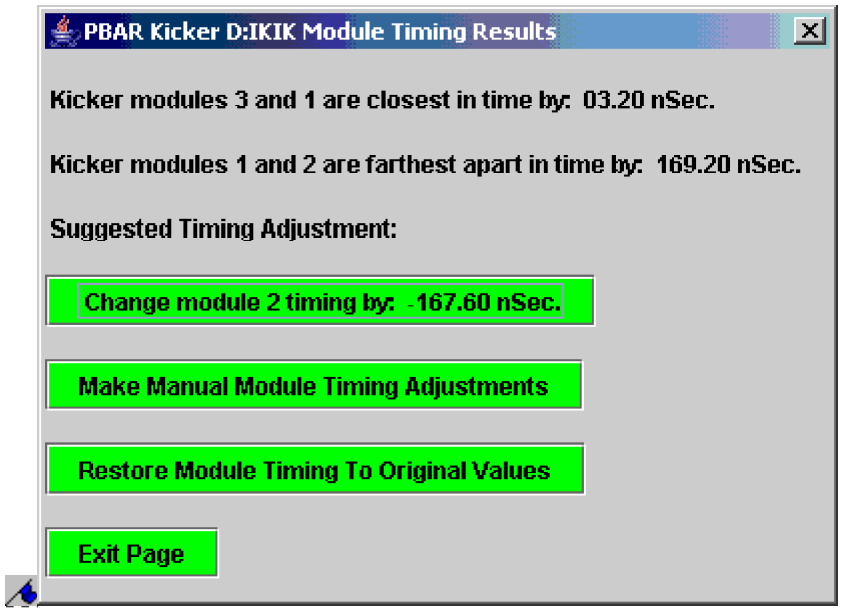

Figure 18:

9. Examine the Pbar Kicker Timing application (see Figure 19) to see if the kicker trace alignment is converging. The value of D:FLXBTL should be the same or larger than that seen in Step 6. Click on the green box that is labeled "Begin Kicker Timing Measurement" as shown in Figure 19.

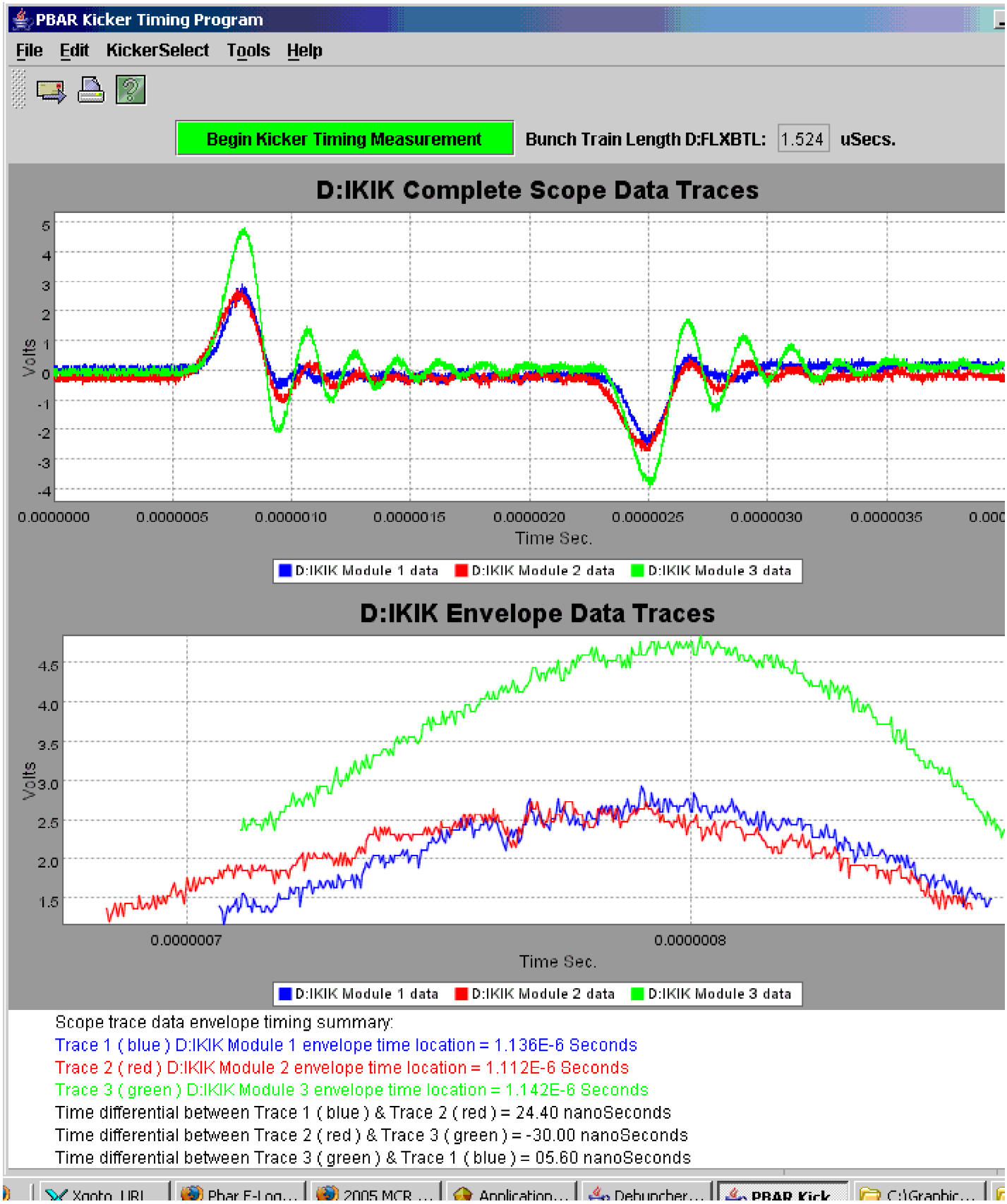

Figure 19: All images should have a figure number.

10. Repeat Step 6 to Step 9 as necessary until all the kicker modules are aligned. Once aligned, a popup window will appear, as shown in Figure 20, that says that all kicker modules are within 20 nanoseconds.

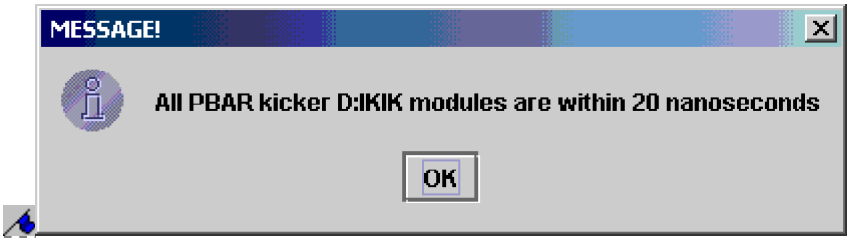

Figure 20:

11. In the next three steps, we will verify that the kicker traces are optimally aligned with the DRF2 gap.
12. As shown in Figure 21 start a FTP from Utility Window FTP Pbar File 104.

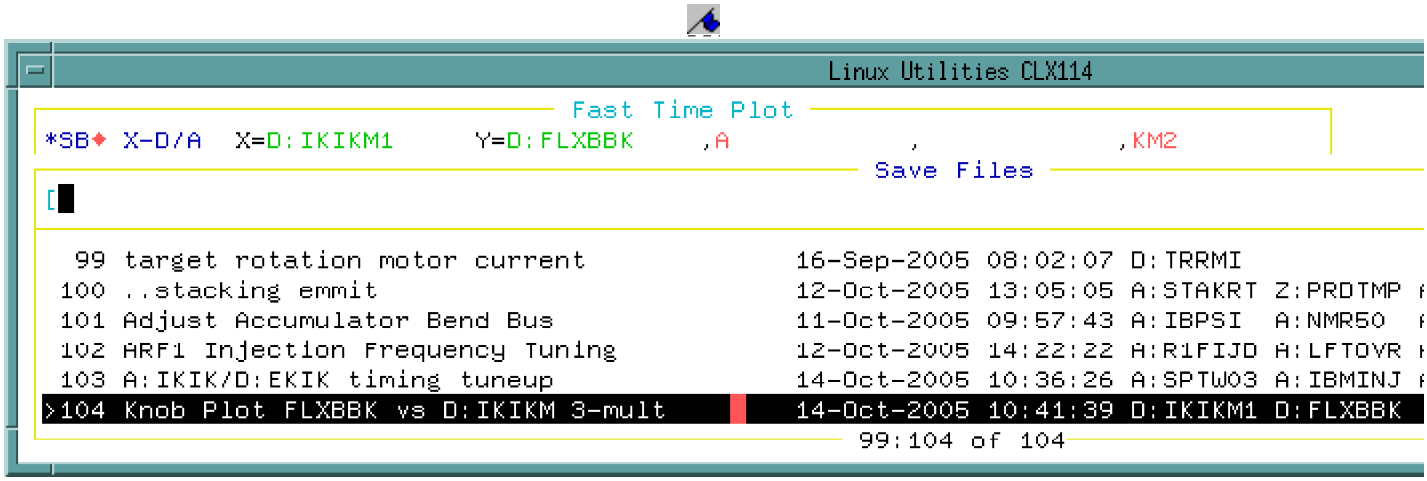

Figure 21:

13. Pbar FTP 104 (see Figure 22) shows how the equivalent number of bunches injected into the Debuncher (D:FLXBBK) is impacted by Debuncher Injection Kicker timing.

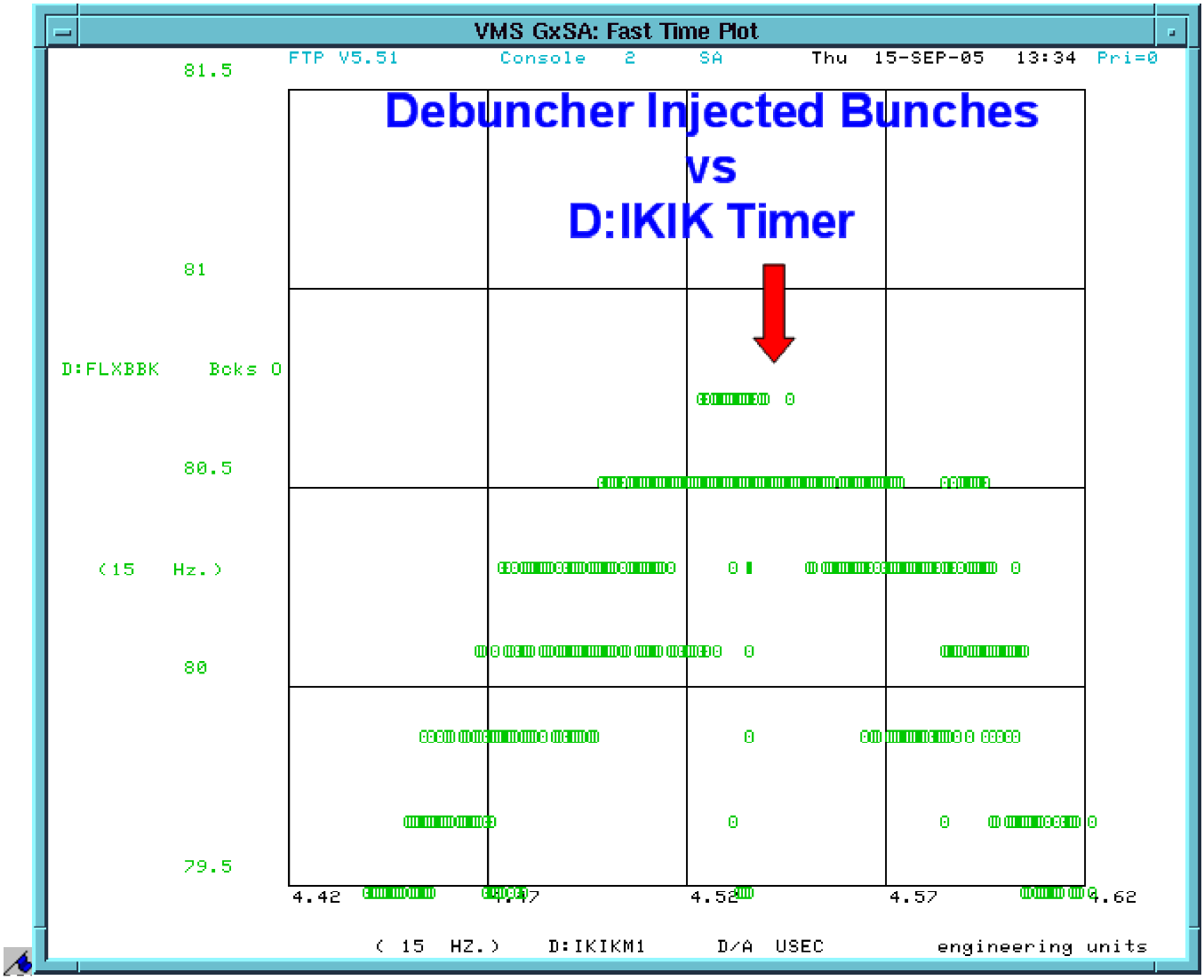

Figure 22:

14. Knob the Debuncher Injection Kicker timing MULT:3 from P60 BOSTR <36> (as shown in Figure 14) to maximize the value of D:FLXBBK. Under normal operating conditions, the parameter peaks at around 80.5 buckets.
15. Document any tuning changes in the Pbar electronic log book.

Full Length Procedure - Part 3: Debuncher Extraction & Accumulator Injection Kicker Tuning (Pbar Experts Only).

This portion of the procedure shows how to tune-up the Debuncher Extraction and Accumulator Injection kicker timers. Due to lack of diagnostics, this portion of the procedure is intended for Pbar experts only.

1. As shown in Figure 23, start a FTP from Utility Window FTP Pbar File 104.

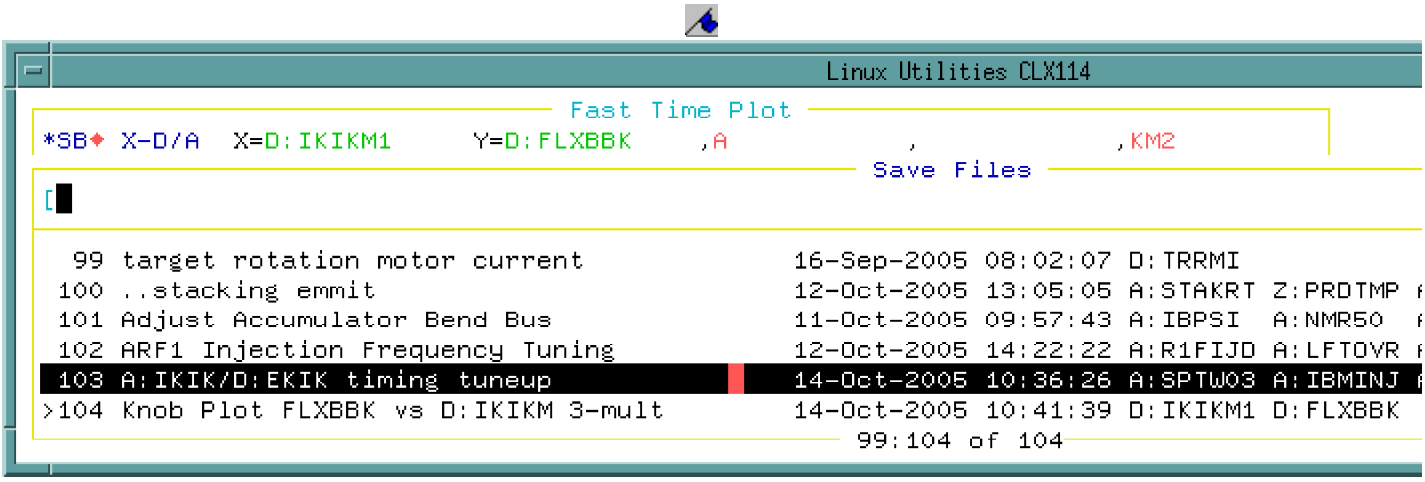

Figure 23:

2. Pbar FTP 104 (see Figure 24) shows one Debuncher Extraction kicker module timer (D:EKIKM1), one Accumulator Injection kicker module timer (A:IKIKM1), the amount of beam injected in the accumulator (A:IBMINJ) in units of 1×10^7 as calculated from the stacking monitor, and the power in one of the stacktail TWTs (A:SPTW03). If our tuning efforts increase the beam to the Accumulator, then value of injected accumulator beam and stacktail power should both increase.

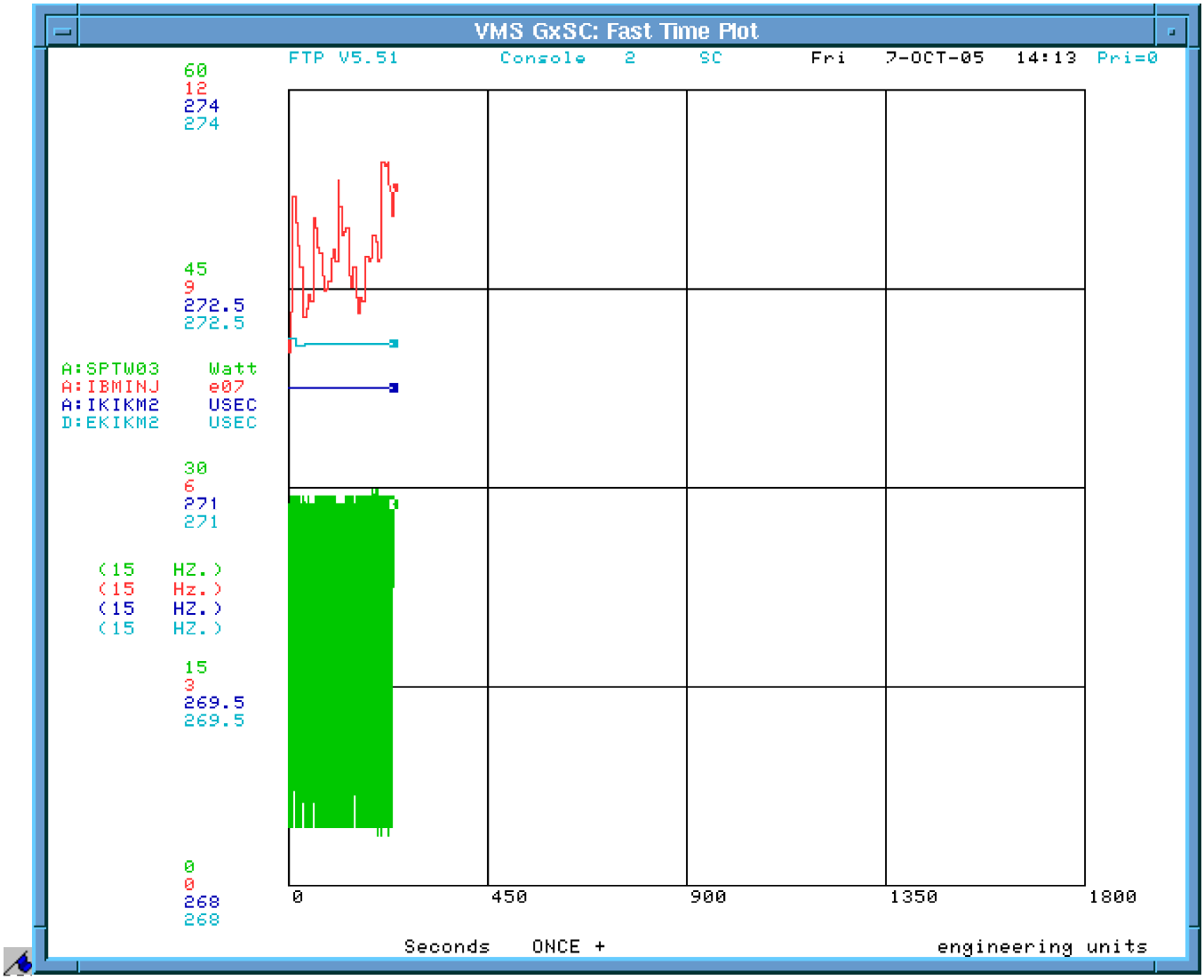

Figure 24:

3. Open P60 DTOA < 3> as shown in Figure 25. This page contains two MULT:3s and one MULT:6 that we will use later in this procedure.

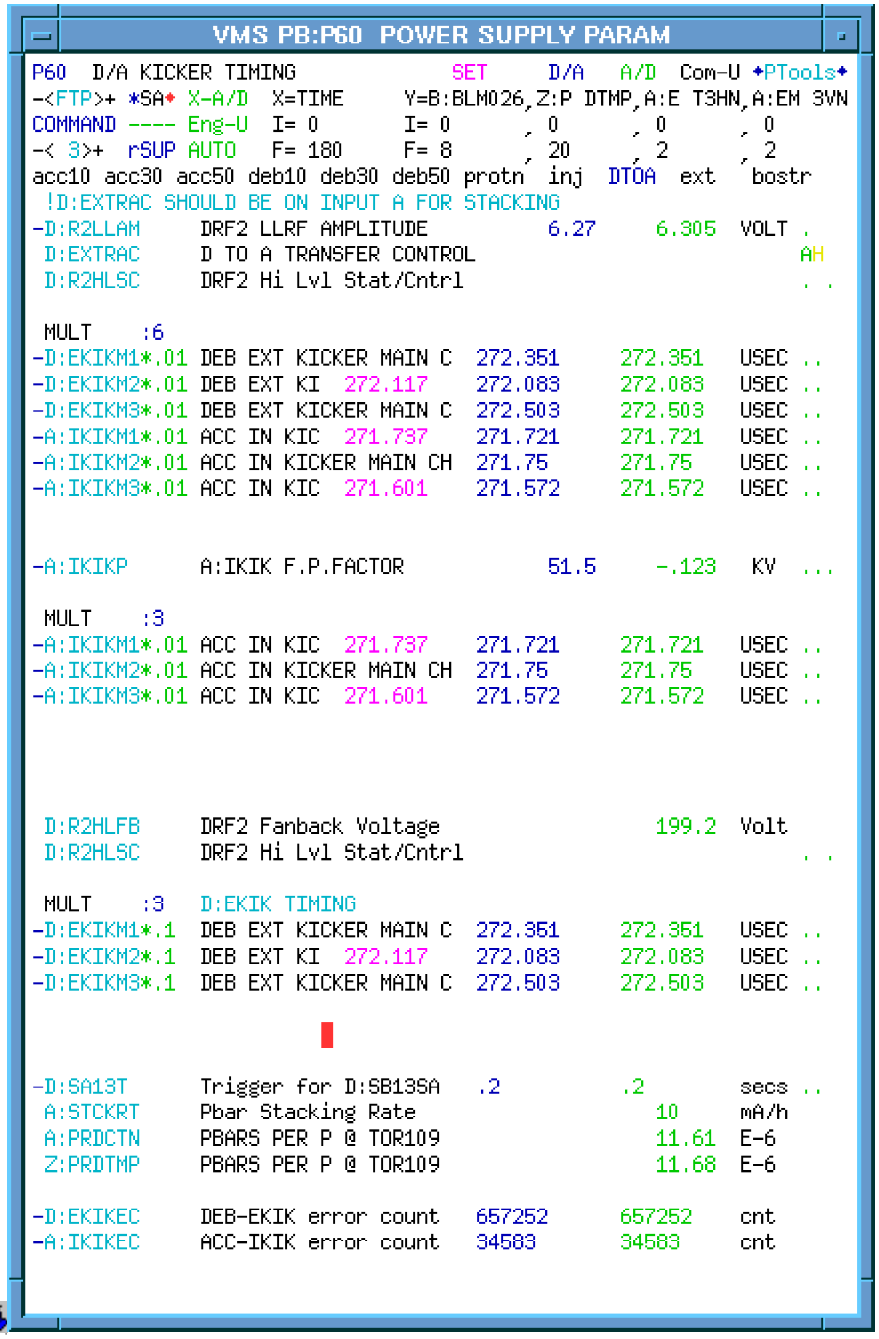

Figure 25:

4. From the Java Kicker Timer Program application, go to "KickerSelect" -> "DebuncherExtraction" as shown in Figure 26.

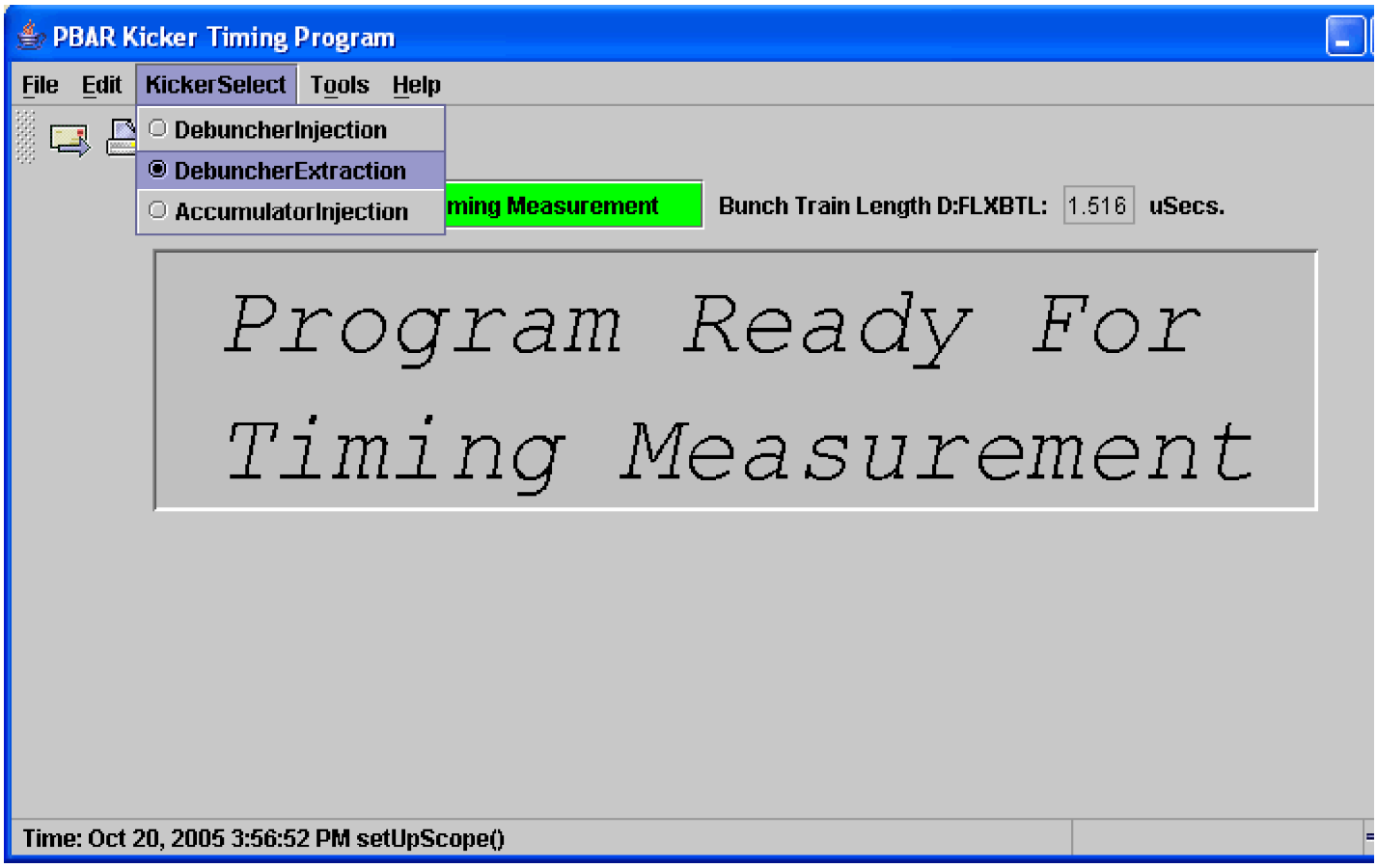

Figure 26:

5. Click on the green box that is labeled "Begin Kicker Timing Measurement" as shown in Figure 27. D:FLXBTL is used for Debuncher injection and can be ignored in this portion of the procedure.

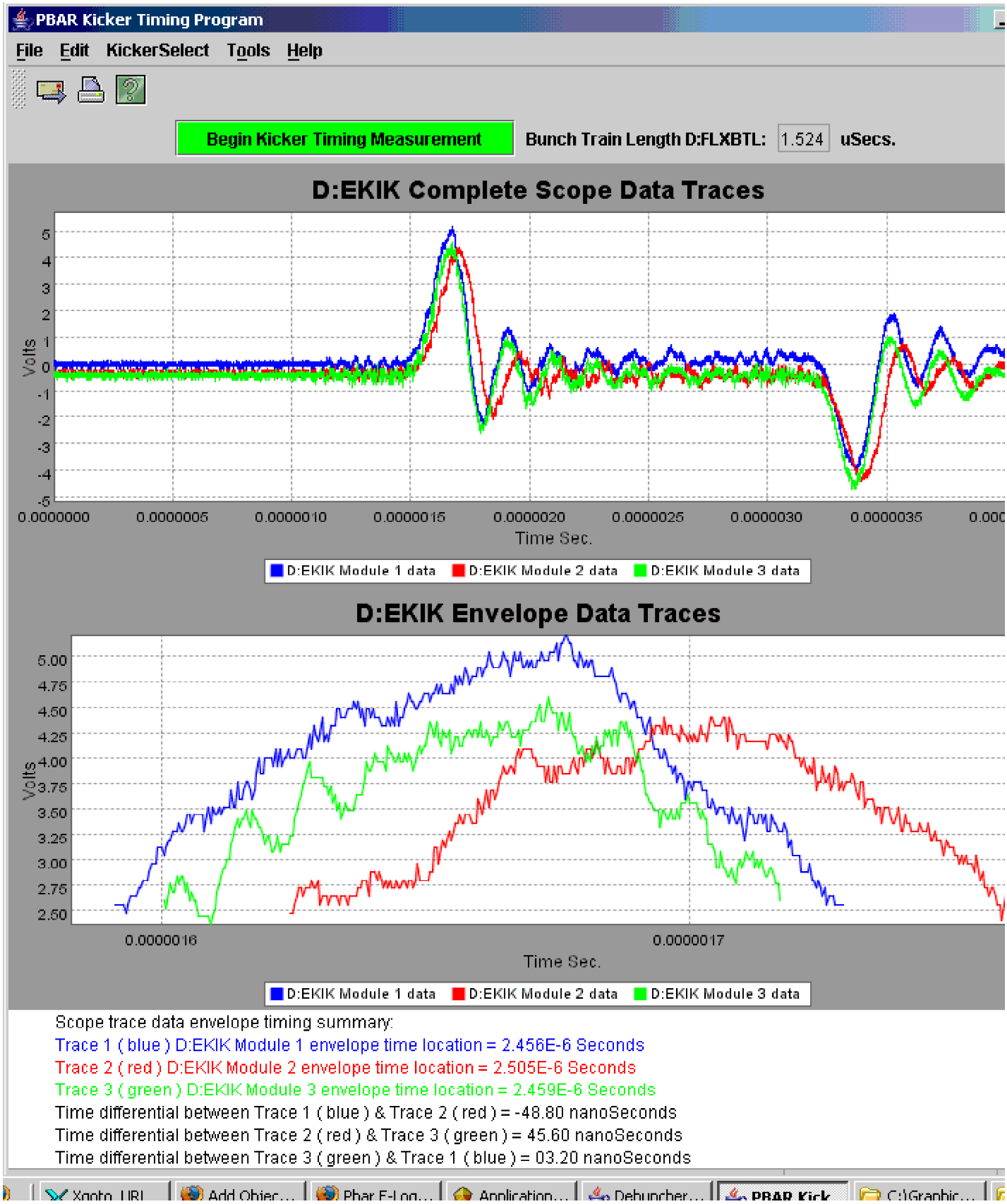
PBAR Kicker Timing Program
File Edit KickerSelect Tools Help
Begin Kicker Timing Measurement
Bunch Train Length D:FLXBTL: 1.524 uSecs.
D:EKIK Complete Scope Data Traces
Volts
Time Sec.
D:EKIK Module 1 data
D:EKIK Module 2 data
D:EKIK Module 3 data
D:EKIK Envelope Data Traces
Volts
Time Sec.
D:EKIK Module 1 data
D:EKIK Module 2 data
D:EKIK Module 3 data
Scope trace data envelope timing summary:
Trace 1 (blue) D:EKIK Module 1 envelope time location = 2.456E-6 Seconds
Trace 2 (red) D:EKIK Module 2 envelope time location = 2.505E-6 Seconds
Trace 3 (green) D:EKIK Module 3 envelope time location = 2.459E-6 Seconds
Time differential between Trace 1 (blue) & Trace 2 (red) = -48.80 nanoSeconds
Time differential between Trace 2 (red) & Trace 3 (green) = 45.60 nanoSeconds
Time differential between Trace 3 (green) & Trace 1 (blue) = 03.20 nanoSeconds

Figure 27:

6. If any tuning changes are required, you will get a popup window, as shown in Figure 28, that states that D:EKIK has timing module differences that exceed 20 nanoseconds. If all of the kicker times are within 20 nanoseconds then skip ahead to Step 10 of this procedure.

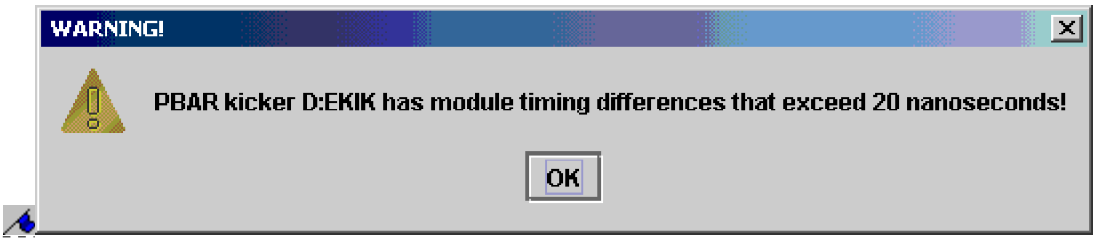

Figure 28:

7. The Timing Results window (see Figure 29) presents the results and suggested tuning options. If the changes look reasonable, then make the suggested changes. It is normal to make ~200nsec changes.

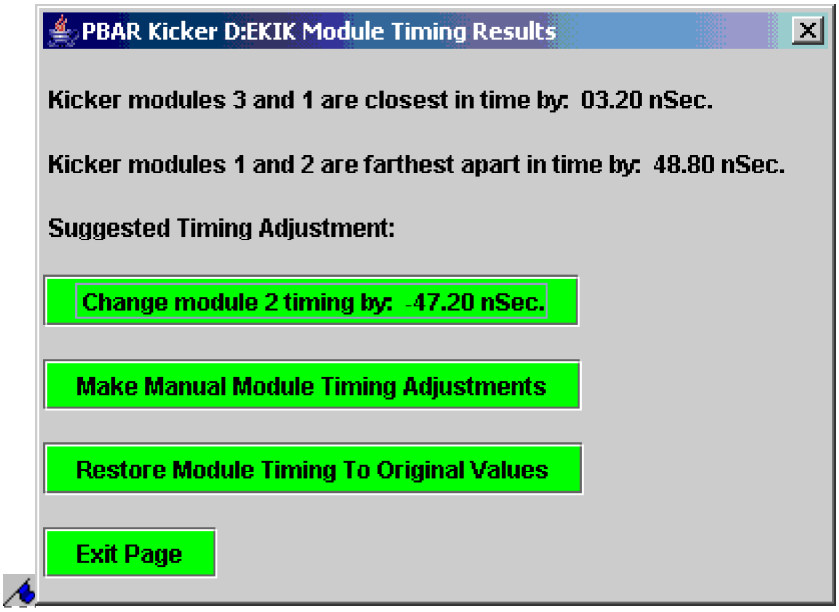

Figure 29:

8. Examine the Pbar Kicker Timing application (see Figure 30) to see if the kicker trace alignment is converging. Click on the green box that is labeled "Begin Kicker Timing Measurement."

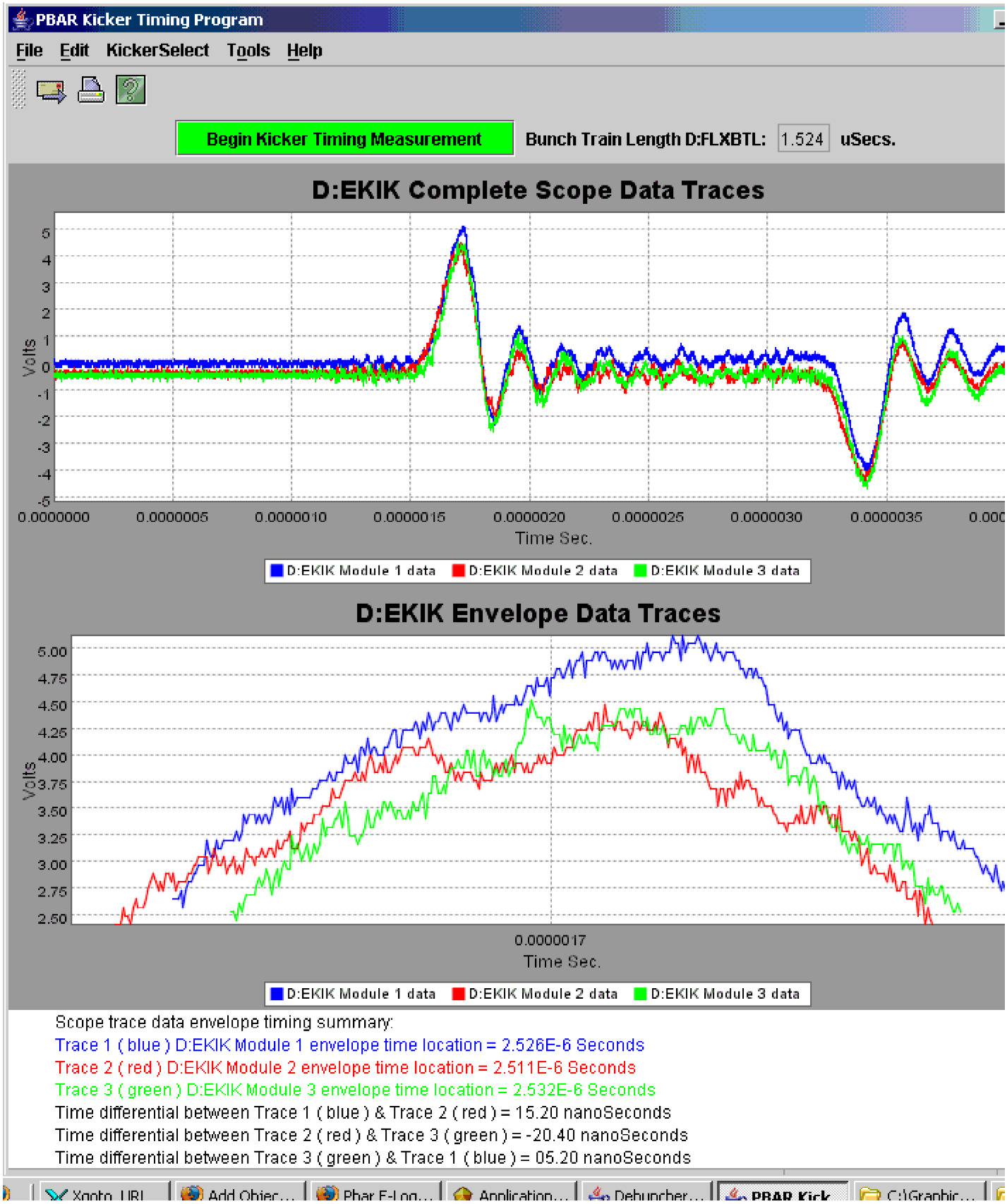
PBAR Kicker Timing Program
File Edit KickerSelect Tools Help
Begin Kicker Timing Measurement
Bunch Train Length D:FLXBTL: 1.524 uSecs.
D:EKIK Complete Scope Data Traces
Volts
Time Sec.
D:EKIK Module 1 data
D:EKIK Module 2 data
D:EKIK Module 3 data
D:EKIK Envelope Data Traces
Volts
0.0000017
Time Sec.
D:EKIK Module 1 data
D:EKIK Module 2 data
D:EKIK Module 3 data
Scope trace data envelope timing summary:
Trace 1 (blue) D:EKIK Module 1 envelope time location = 2.526E-6 Seconds
Trace 2 (red) D:EKIK Module 2 envelope time location = 2.511E-6 Seconds
Trace 3 (green) D:EKIK Module 3 envelope time location = 2.532E-6 Seconds
Time differential between Trace 1 (blue) & Trace 2 (red) = 15.20 nanoSeconds
Time differential between Trace 2 (red) & Trace 3 (green) = -20.40 nanoSeconds
Time differential between Trace 3 (green) & Trace 1 (blue) = 05.20 nanoSeconds

Figure 30:

9. Repeat Step 5 through Step 8 until the kicker traces are aligned within 20 nanoseconds.
10. From P60 DTOA < 3>, as shown in Figure 25, slowly knob the D:EKIKM% (% = 1, 2, or 3) MULT:3 to optimize the kicker with respect to the DRF2 gap. Watch the FTP as well as stackrate and production.
11. From the Java Kicker Timer Program application, go "KickerSelect" -> "AccumulatorInjection" as shown in Figure 31.

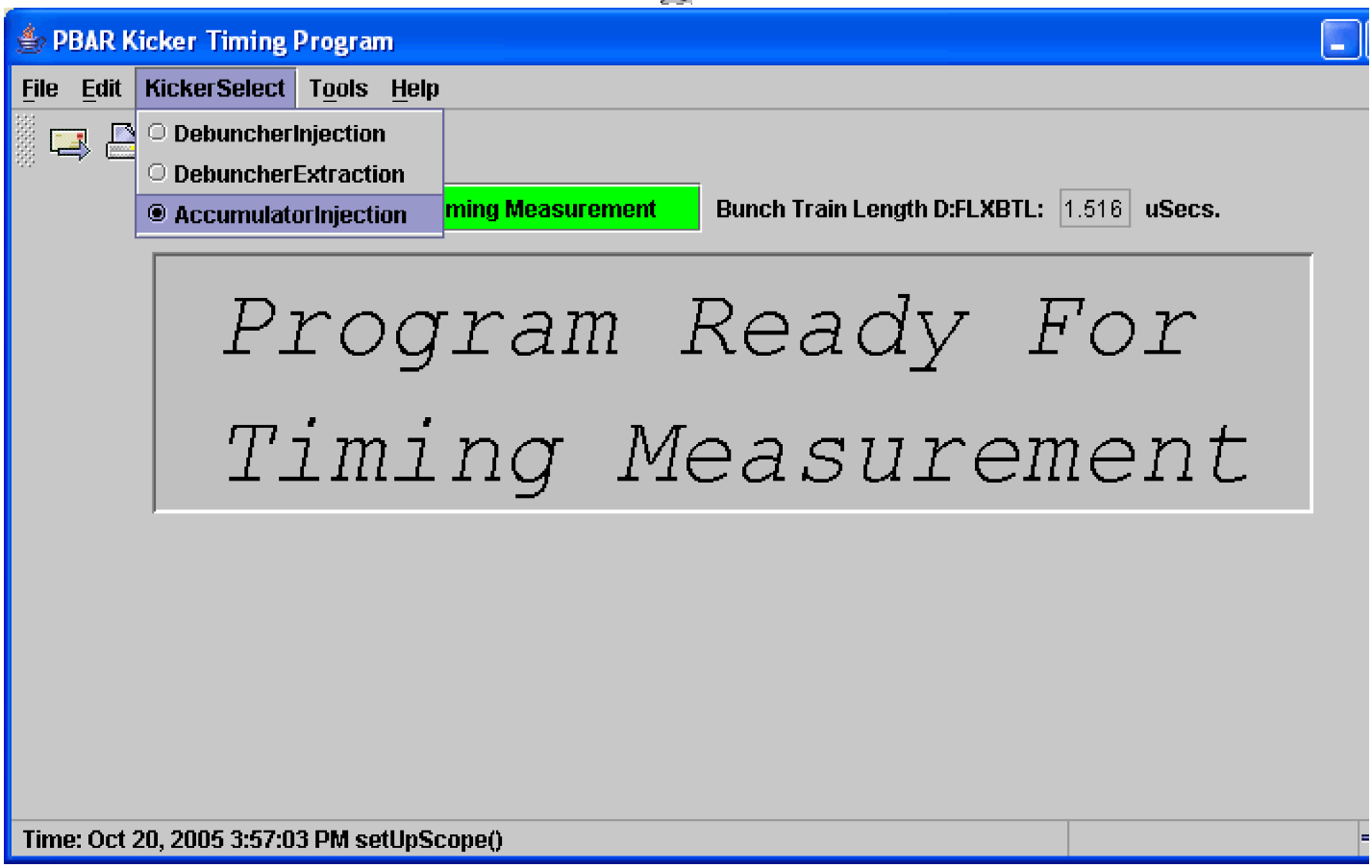

Figure 31:

12. Click on the green box that is labeled "Begin Kicker Timing Measurement" as shown in Figure 32. D:FLXBTL is used for Debuncher injection and can be ignored in this portion of the procedure.

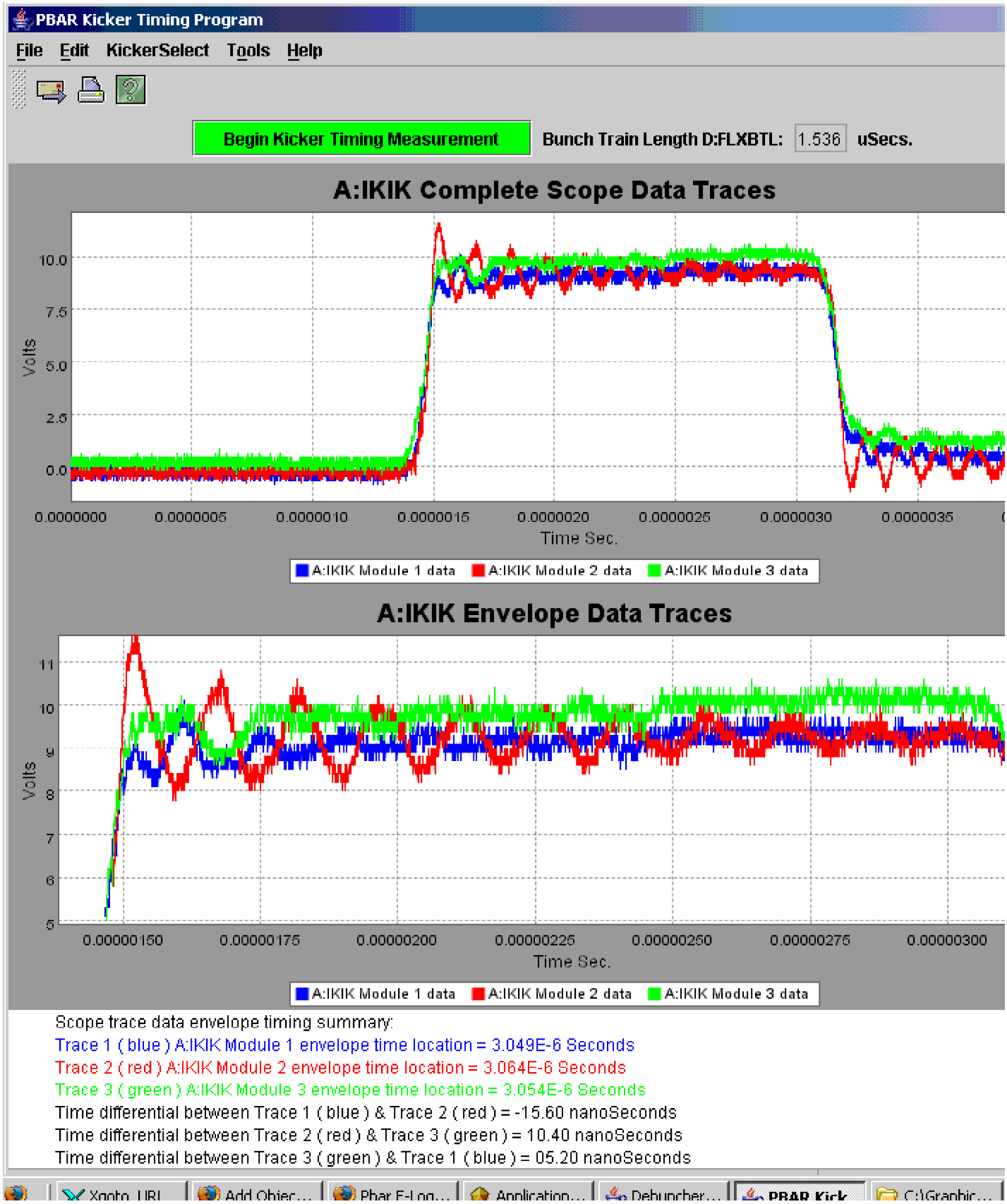
PBAR Kicker Timing Program
File Edit KickerSelect Tools Help
Begin Kicker Timing Measurement
Bunch Train Length D:FLXBTL: 1.536 uSecs.
A:IKIK Complete Scope Data Traces
Volts
Time Sec.
A:IKIK Module 1 data
A:IKIK Module 2 data
A:IKIK Module 3 data
A:IKIK Envelope Data Traces
Volts
Time Sec.
A:IKIK Module 1 data
A:IKIK Module 2 data
A:IKIK Module 3 data
Scope trace data envelope timing summary:
Trace 1 (blue) A:IKIK Module 1 envelope time location = 3.049E-6 Seconds
Trace 2 (red) A:IKIK Module 2 envelope time location = 3.064E-6 Seconds
Trace 3 (green) A:IKIK Module 3 envelope time location = 3.054E-6 Seconds
Time differential between Trace 1 (blue) & Trace 2 (red) = -15.60 nanoSeconds
Time differential between Trace 2 (red) & Trace 3 (green) = 10.40 nanoSeconds
Time differential between Trace 3 (green) & Trace 1 (blue) = 05.20 nanoSeconds

Figure 32:

13. If any tuning changes are required, you will get a popup window, as shown in Figure 33, that states that A:IKIK has timing module differences that exceed 20 nanoseconds. If all of the kicker times are within 20 nanoseconds then skip ahead to Step 17 of this procedure.

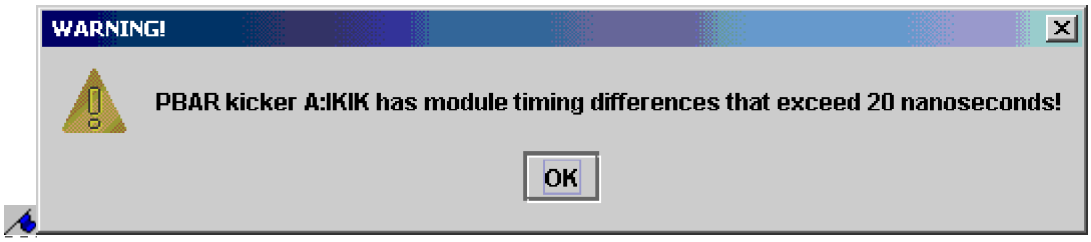

Figure 33:

14. The Timing Results window (see Figure 34) presents the results and suggested tuning options. If the changes look reasonable, then make the suggested changes. It is normal to make ~200nsec changes.

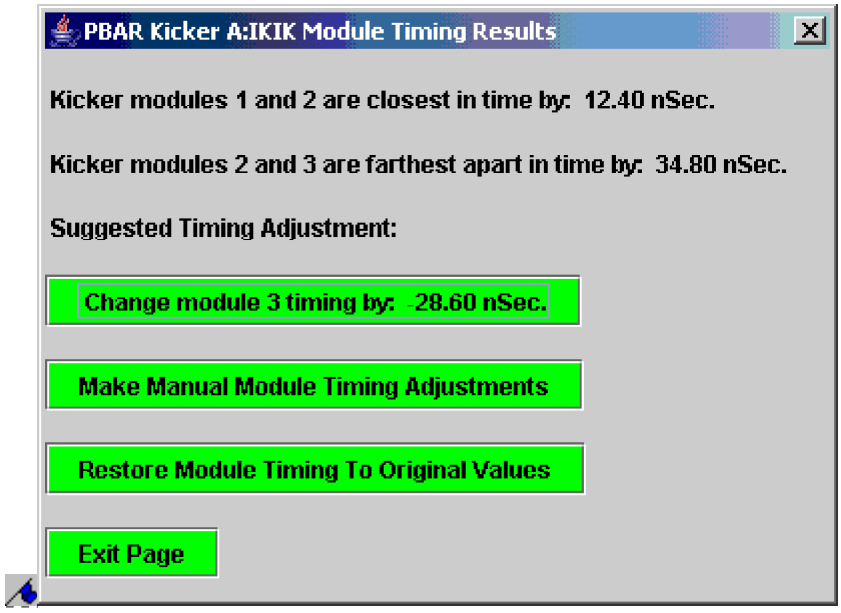

Figure 34:

15. Examine the Pbar Kicker Timing application (see Figure 35) to see if the kicker trace alignment is converging. Click on the green box that is labeled "Begin Kicker Timing Measurement."

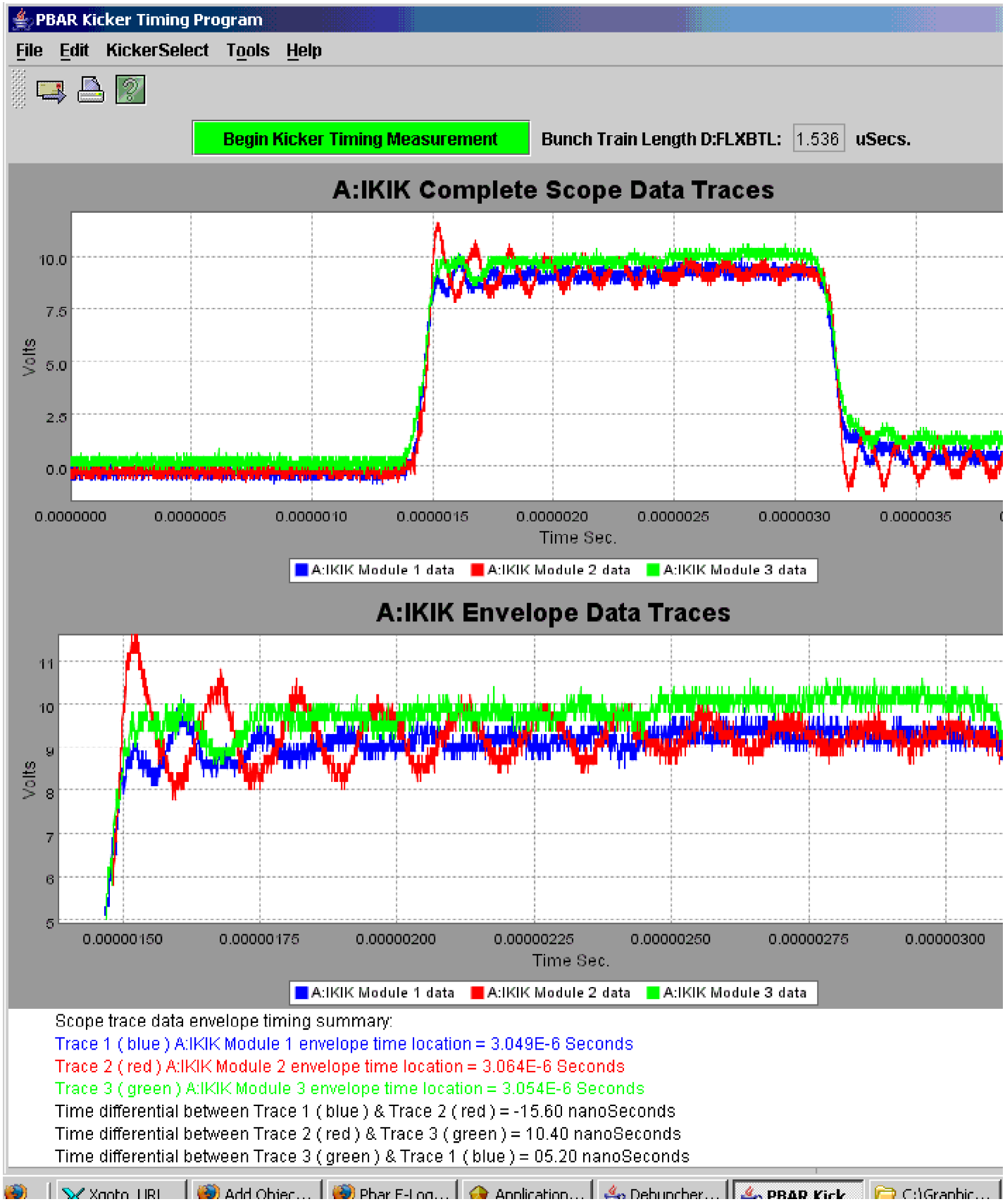
PBAR Kicker Timing Program
File Edit KickerSelect Tools Help
Begin Kicker Timing Measurement
Bunch Train Length D:FLXBTL: 1.536 uSecs.
A:IKIK Complete Scope Data Traces
Volts
Time Sec.
A:IKIK Module 1 data
A:IKIK Module 2 data
A:IKIK Module 3 data
A:IKIK Envelope Data Traces
Volts
Time Sec.
A:IKIK Module 1 data
A:IKIK Module 2 data
A:IKIK Module 3 data
Scope trace data envelope timing summary:
Trace 1 (blue) A:IKIK Module 1 envelope time location = 3.049E-6 Seconds
Trace 2 (red) A:IKIK Module 2 envelope time location = 3.064E-6 Seconds
Trace 3 (green) A:IKIK Module 3 envelope time location = 3.054E-6 Seconds
Time differential between Trace 1 (blue) & Trace 2 (red) = -15.60 nanoSeconds
Time differential between Trace 2 (red) & Trace 3 (green) = 10.40 nanoSeconds
Time differential between Trace 3 (green) & Trace 1 (blue) = 05.20 nanoSeconds

Figure 35:

16. Repeat Step 12 through Step 15 until the kicker traces are aligned within 20 nanoseconds as shown in Figure 36.

Figure 36:

17. From P60 DTOA < 3>, as shown in Figure 25, slowly knob the A:IKIKM% (% = 1, 2, or 3) MULT:3 to optimize the A:IKIK kicker with respect to the D:EKIK kicker timing. Watch the FTP as well as stackrate and production.
18. From P60 DTOA < 3>, as shown in Figure 25, slowly knob the D:EKIKM% (% = 1, 2, or 3) + A:IKIKM% (% = 1, 2, or 3) MULT:6 to optimize both kickers in respect to the DRF2 gap. Watch the FTP as well as stackrate and production.
19. When in doubt, put your changes back.
20. Document any tuning changes in the Pbar electronic log book.

Condensed Procedure:

The following is a condensed checklist of the steps covered in the above procedure. No screen captures nor motivating discussion are provided in this section. For more detail, discussion and screen captures, read the Full Length Procedure above.

1. **Start the Java Kicker Timing Application**
   a. The Java application can be started by clicking on the following link: http://www-bd.fnal.gov/appix/start?p=40000142&n=35000508. The application can also be started from the Java Index. One open, click on "Launch in Application Browser." The Application Index window appears. Open the P * Pbar folder and double click on "Pbar Kicker Timing."
   b. Once the application is open, we can complete either of the following two procedures.
      a. **D:IKIK timer tuning (Ops and Experts)**
      b. **D:EKIK & A:IKIK timer tuning (Experts only)**

D:IKIK Timer Tuning (Ops and Experts)

1. **Tuning D:IKIK timers (Ops and Experts)**
   a. Start Utilities Windows FTP Pbar plot #87
   b. Click on "KickerSelect" in the menu bar and select "Debuncher Injection Kicker."
   c. Click on "Begin Kicker Timing Measurement."
   d. A pop-up window will appear:
      i. If the popup window states that all kickers are within the 20nsec tolerance, then click ok and skip to step 1.g
      ii. If the popup window states that there is at least one kicker more than 20nsec out of tolerance, click ok and continue to step 2.f
   e. Another popup window appears showing the timing results. Click to make the recommended changes.
   f. Repeat steps 1.c-1.e above until all kicker traces are aligned.
   g. If D:FLXBBK < 80 buckets, or if D:FLXBBK decreased after tuning, then go to step 2.
2. **Verifying D:IKIK mult is optimized.**
   a. Start Utilities Windows FTP Pbar plot #104
   b. Knob the D:IKIKM 3-mult on page P60 Boostr <36> to maximize D:FLXBBK, which should be greater than 80.5 buckets.
3. If D:FLXBBK is still < 80 buckets, start the Proton Torpedo SA from P194.
   a. If the Proton Torpedo shows less than injected 81 buckets, go back to your Booster and Main Injector tuning procedures to find what is wrong.
   b. If the Proton Torpedo shows 81 injected buckets, then contact a Pbar on-call expert.
4. Document any tuning changes in the Pbar electronic log book.
5. For a more detailed treatment of this procedure, please see the Full Procedure.

D:EKIK & A:IKIK Timer Tuning (Experts Only)

1. **Tuning D:EKIK timers (expert only)**
   a. Start Utilities Windows FTP Pbar plot #103
   b. Go To P60 DtoA < 3>.
   c. Click on "KickerSelect" in the menu bar and select "Debuncher Extraction Kicker."
   d. Click on "Begin Kicker Timing Measurement."
   e. A pop-up window will appear:
      i. If the popup window states that all kickers are within the 20nsec tolerance, then click ok and skip to step 5.
      ii. If the popup window states that there is at least one kicker more than 20nsec out of tolerance, click ok and continue to step 4.f

f. Another popup window appears showing the timing results. Click to make the recommended changes.
g. Repeat steps 4.c-4.f above until all kicker traces are aligned.

2. **Tuning A:IKIK timers (expert only)**
   a. Start Utilities Windows FTP Pbar plot #103
   b. Go To P60 DtoA < 3>
   c. Click on "KickerSelect" in the menu bar and select "Accumulator Injection Kicker."
   d. Click on "Begin Kicker Timing Measurement."
   e. A pop-up window will appear:
      i. If the popup window states that all kickers are within the 20nsec tolerance, then click ok and skip to step 6.
      ii. If the popup window states that there is at least one kicker more than 20nsec out of tolerance, click ok and continue to step 5.f
   f. Another popup window appears showing the timing results. Click to make the recommended changes.
   g. Repeat steps 5.c-5.f above until all kicker traces are aligned.
   h.
3. **Verifying D:EKIK & A:IKIK 3-Mults and 6-Mult (expert only)**
   a. Start Utilities Windows FTP Pbar plot #103
   b. Go To P60 DtoA < 3>.
   c. Knob D:EKIK timer 3-mult to maximize Accumulator beam.
   d. Knob A:IKIK timer 3-mult to maximize Accumulator beam.
   e. Knob A:IKIK & D:EKIK timer 6-mult to maximize Accumulator beam.
4. Document any tuning changes in the Pbar electronic log book.
5. For a more detailed treatment of this procedure, please see the Full Procedure.

Printable Version:

The html version of this document is best for viewing, but not necessarily the best for printing. A printable version of this document is located in the Accelerator Division Documents Database at {*link to PDF file here*}.
